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PROCEEDINGS OF THE PUBLIC HEARINGS

OCTOBER, 1972

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ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS

PROCEEDINGS OF THE PUBLIC HEARINGS

OCTOBER, 1972

PART I

ENVIRONMENT CONSERVATION
AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

THE PROCEEDINGS ARE PUBLISHED IN THREE VOLUMES.

VOLUME I CONTAINS THE CONSULTANT'S REPORT, AND THE PROCEEDINGS OF HEARINGS HELD IN PINCHER CREEK, RED DEER AND WHITECOURT.

VOLUME II CONTAINS THE PROCEEDINGS OF THE HEARINGS HELD IN CALGARY.

VOLUME III CONTAINS THE PROCEEDINGS OF THE HEARING HELD IN EDMONTON; AS WELL AS SUPPLIMENTARY SUBMISSIONS TO THE AUTHORITY, CRITIQUES ON BRIEFS PRESENTED AT THE HEARINGS AND APPENDICIES..

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MARCH, 1973.

FOREWORD

The Province of Alberta has two great natural advantages. On the one hand, the land surfaces the Province presents to the world are varied, richly endowed, and extensively used for agriculture, for forestry and for recreation, virtually over the entire area of the Province. On the other hand, below the surface and again throughout the Province, seam upon seam of coal is found, and oil, gas, tar sands and other minerals. To be jointly endowed with great subsurface energy resources, and at the same time to possess abundant fertile and enjoyable ever-renewable resources throughout makes the Province twice blessed. At the same time problems can arise when the various surface and subsurface resources are used in ways which are not compatible with each other.

The nature of the impact that subsurface resource developments can have on the surface regions depends directly on the nature of the subsurface resource that is being developed. Surface mining to recover coal creates rather a different disturbance than boring a hole to great depth to recover oil or gas. On the other hand, coal in Alberta is in a sense relatively clean since it possesses rather low sulphur contents. By contrast some of the natural gas deposits in Alberta may be highly sulphurous, and the release to the surface of these potent gaseous mixtures may include besides hydrocarbon compounds such as hydrogen sulphide, mercaptans and carbon dioxide intermixed with water that may have salt dissolved in it. Unlike coal which as a solid is easier to contain within a given space, these gases and liquids, once released from their underground confinement, can unless they are closely managed have profound and widespread effects on the air, the land, the water and on people. For this reason they are closely managed. The oil and gas industry is a technologically intensive industry in all its aspects. This becomes even more marked when sulphur is present in natural gas since this element, in several of the forms it can assume, is known to have profound effects on living species in both the plant and animal kingdoms.

The Environment Conservation Authority has been requested by the Government of Alberta to conduct comprehensive and wide-ranging hearings on the impact on the environment of resource development in Alberta. The Authority has recently completed its "Report and Recommendations on the Impact on the Environment of Surface Mining in Alberta" and this was tabled in the Legislative Assembly in the fall session of 1972.

In this continuing series of public enquiries, the Authority next directed its attention, at the request of the Honourable Mr. Yurko, the Minister of the Environment, to the environmental effects of the operation of sulphur extraction gas plants. There had been a considerable history of concern as to how the lives and livelihoods of some of the citizens in the Province were being affected by the operations of the sour gas industry in their immediate neighbourhoods.

As a background to the public hearings, the Authority released its "Terms of Reference" and a "Prospectus on the Environmental Effects of the Operation of Sulphur Extraction Gas Plants," together with a comprehensive review, "The Environmental Effects of the Operation of Sulphur Extraction Gas Plants," by Dr. R. F. Klemm.

The Klemm Report brought together all relevant and known information about the operations of sulphur extraction gas plants and the physical and regulatory conditions under which they operate, analyzed the sources of possible environmental contaminants within these plants, discussed the methods and efficiencies of sulphur removal, and summarized what was known as to the effects of pollutants on air quality and human health, on farm livestock, on vegetation and on soil. The Klemm Report was circulated widely prior to the hearings and became an important basis of information for the public enquiry. Supported by this background work, the Authority then held hearings during October 1972 in Pincher Creek, Red Deer, Whitecourt, Calgary and Edmonton.

The present volumes contain the "Proceedings of the Public Hearings into the Environmental Effects of the Operation of Sulphur Extraction Gas Plants."

ACKNOWLEDGMENTS

The contribution that a public hearing can make to the advancement of any subject depends very largely on the submissions, briefs and presentations made to it by members of the public. The Environment Conservation Authority is very appreciative of the considerable effort of individuals, groups and associations in preparing their submissions to the hearings, and indeed in acting to bring about the hearings themselves.

It is also most helpful and desirable if those who prepare submissions can have ready access to relevant information dealing with the subject under enquiry.

The Authority wishes particularly to acknowledge the invaluable and highly expert contribution made by Dr. Roger Klemm in his report, "The Environmental Effects of the Operation of Sulphur Extraction Gas Plants," which was widely used by many people before, during and indeed after the hearings. The Environment Conservation Authority is most appreciative of the arrangement entered into by the Research Council of Alberta whereby Dr. Klemm was released from his normal duties to undertake this important project.

The Authority also very much appreciates the thorough and thoughtful way in which the submissions were prepared and presented throughout the hearings. There was inevitably a protagonist element associated with the hearings, and in some cases a history of past conflict not yet always resolved in a mutually satisfactory way. The Authority notes the additional element of courage required of an individual who speaks only for himself, and commends those citizens who took upon themselves this lonely and difficult task. The Authority also very much appreciates the thorough, candid and objective way in which the industry analyzed its own operations and attempted to objectively assess the environmental effects of its operations.

Important and in some cases quite original contributions were also made by highly expert individuals either on their own disinterested behalf or as spokesmen for groups or associations. The opportunity to see these different facets of the problem put together under questioning and examination by the Authority so that it made a complete, well-balanced though complex story was a welcome and salutary experience.

Above all, the Authority wishes to commend the citizens of the province for the direct, honest, effective and reasonable way in which they approach problems that are not simple and involve conflicts between vital and personal interests.

DR. W. R. TROST,
Chairman,
Environment Conservation Authority.

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INTRODUCTION

The Environment Conservation Authority was requested by the Honourable W.J. Yurko, Minister of the Environment, to hold public hearings on the environmental effects of the operation of sulphur extraction gas plants in Alberta. The hearings took place during October, 1972 in Pincher Creek, Red Deer, Whitecourt, Calgary and Edmonton.

PRE-HEARING PREPARATION

At the request of the Environment Conservation Authority the Research Council of Alberta provided the services of a consultant to prepare a situation report on the environmental effects of sulphur extraction gas plants. The report presented an overview of the subject and provided a basis for discussion. Topics discussed in this report included: the magnitude of the sulphur industry; extraction plant operation; plant effluents; meteorological dispersal of gaseous pollutants particularly sulphur dioxide; effects on humans, animals and vegetation of various pollutants and what is known about them; and pollution control legislation affecting the sulphur extraction plants. This report was released to the public before the hearings as background information.

To ensure an adequate response from the public, a wide mailing was made of material such as the terms of reference and the prospectus for the public hearings as well as press releases to the media.

The dates and places of the hearings were as follows:

Pincher Creek	- October 2, 1972
Red Deer	- October 5, 1972
Whitecourt	- October 11, 1972
Calgary	- October 16, 1972
Edmonton	- October 19, 1972

Relevant industries, unions, interested groups and individuals were invited to participate in the hearings by preparing briefs.

INTRODUCTION

OCTOBER, 1972

ENVIRONMENT CONSERVATION
AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

Advertising for the hearings was carried out through one minute announcements on radio and television, as well as advertisements placed in the daily and weekly newspapers in Alberta.

As further background material a Prospectus for public hearings and Terms of Reference for the public hearings were printed and distributed to a selected mailing list in advance of the hearings. The Terms of Reference covered such material as environmental effects, major chemical constituents, plant operation, sulphur, sulphur compounds, side effects, and objectives within the hearings. The Prospectus gave a brief description of the scope of the subject matter of the hearings, its background and the present and future considerations which were relevant.

THE PUBLIC HEARINGS

At each of the hearings the session was opened with an introductory address by the Chairman of the Authority. He then called upon Dr. Klemm who had prepared the situation report to present his report in summary form. The panel, consisting of Dr. W.R. Trost, Chairman; Dr. S.B. Smith, Board Member; and Mr. W.A. Flook, Executive Co-Ordinator; questioned Dr. Klemm on various aspects of his report at each of the hearings in order to set the scene and supply basic information to the people attending the hearings. Briefs were then summarized and read by persons representing interested companies, or by individuals who had submitted briefs privately. The Authority then questioned those who had made submissions in order to fully elucidate the concepts and opinions put forward by them.

In total there were 62 briefs presented at the five hearings.

SUPPLEMENTARY SUBMISSIONS

A number of briefs were forwarded to the Authority by individuals or representatives of organizations who were either unable to attend the hearings or wished to supply further information. These included bibliographies, other reports used as references, as well as critiques on various other briefs presented at the hearings.

REPORTS OF THE HEARINGS

A verbatim transcript of all the oral submissions as well as the discussion was compiled from tape recordings of each of the hearings. It is not published but is available for inspection by anyone at the offices of the Authority.

A complete video tape record was also made, and from this a one hour documentary was prepared for use by cable and educational T.V. systems.

The proceedings recorded in these volumes consist of all the written submissions received by the Authority on the subject plus the discussions which followed those that were presented orally at the hearings. These volumes are available to the public at a cost of $6 for the set.

The Report and Recommendations of the Authority is presented to the Minister of the Environment for tabling in the Legislature. It contains a concise summary of the Hearings and is a confidential document until it is tabled in the House. At that time it will become freely available to the public on request to the Authority.

SITUATION REPORT

OCTOBER, 1972

ENVIRONMENT CONSERVATION
AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

FOREWORD

This report on the Environmental Effects of Sulfur Extraction Gas Plants in Alberta is made available to the public by the Environment Conservation Authority for the purposes of the public hearings. The Authority does not take the position of necessarily agreeing or disagreeing with any or all of the statements in the report. It is expected that participants in the hearings will find the report meaningful in providing general background information, that they will amplify on portions of the report, and that they will also introduce new information.

The report has been prepared by Dr. Roger F. Klemm, of the Research Council of Alberta, whose time was made available as a consultant for the period of the task. The material in this report has been released with the approval of the Government of Alberta. Dr. Klemm will also devote additional time to the subject prior to and during the public hearings on Sulfur Extraction Gas Plants.

The Environment Conservation Authority is most appreciative of the arrangement entered into by the Research Council of Alberta whereby Dr. Klemm has been released from his normal duties to undertake this project.

Dr. W. R. Trost
Chairman
Environment Conservation Authority

ACKNOWLEDGEMENT

Approximately two and one-half months were allotted to information athering. An additional month was spent in bringing the material collected o its present form. This will indicate the time constraint imposed upon he depth to which any given subject could be treated.

During the preparation of the report time and information in many forms was solicited from numerous members of the community at large as well as experts in government, industry and labour. So as not to overlook even the slightest contributor the consultant wishes to offer his whole-hearted appreciation and thanks to this large group of interested citizens, all of whom unfortunately will have to pass into anonymity as individuals at this time. Chapter IV was prepared with the assistance of the staff of the Department of the Environment.

The concern and assistance of all members and staff of the Environment Conservation Authority merit particular commendation, especially Dr. W.R. MacDonald who provided the important liaison between the consultant and the sources of information cited above.

R. F. Klemm
August 15, 1972

DOCUMENTATION OF REFERENCES

All original material referenced in the present report has been placed on file at the offices of the Environment Conservation Authority in Edmonton. In addition, a file of more general information relating to the environmental aspects of sulfur extraction processes will be available in the offices of the Authority for interested parties.

Interdepartmental memorandums in Government are considered as confidential material unless released by Ministerial approval.

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B. RECOVERY INCREASED TO 99%
C. ADD ANOTHER CLAUS CONVERTER TO INCREASE RECOVERY TO 96% 83

FIGURE 8.2 OPERATING COSTS FOR RECOVERY FACILITIES BEGINNING WITH A CLAUS PLANT OF 95% SULFUR RECOVERY. A, B, C AS FOR FIGURE 8.1 84

FIGURE 8.3 SULFUR DIOXIDE IN INCINERATOR STACK GAS VERSUS PERCENT OF SULFUR RECOVERED 86

INTRODUCTION

This resume of the sour gas industry and its attendant impact upon the province of Alberta has been prepared under the sponsorship of the Alberta Environment Conservation Authority. Its intended purpose was to "outline the present situation in Alberta concerning sulfur extraction plants and to describe the present technology employed in sulfur extraction".

In treating this subject it was further specified that such a report should enter into a generalized discussion of the following items as they pertain to sour gas handling.

1. Outline the history of sulfur extraction in Alberta.
2. Indicate present plants, output, economics, etc.
3. Identify benefits that are derived directly from the industry in terms of employment, income with respect to the general economy.
4. Review various processes used in recovery.
5. Discuss overall plant operation, transmission of the gases to the plants, and methods of stockpiling sulfur.
6. Discuss the uses of sulfur.
7. Discuss the transportation of sulfur.
8. Discuss problems of plants: corrosive gases, effluents, toxic chemicals.
9. Discuss emissions, limits, and the means of attaining these limits.
10. Discuss measuring techniques for air pollution, determination of stack heights, monitoring techniques and present practices in Alberta.
11. Discuss meteorological dispersal of pollutants and the resultant return of these pollutants to earth.
12. Discuss the effects of sulfur dioxide, hydrogen sulfide, and other toxic compounds on humans.
13. Discuss the effects of the above compounds on animals and plants.
14. Discuss the effects, etc. of these compounds known to have occurred in Alberta.
15. Discuss current legislation and regulations applicable to the area of environmental control, particularly paying attention

to those affecting sulfur extraction plants.

16. Mention some questions that may be asked concerning the operation limits, etc., of sulfur recovery plants in Alberta.

While the above listing would seem to be all-encompassing, it was not intended that these issues were to be taken as the absolute boundaries for the presentation at hand. Thus, although the format of the appended report follows closely the guidelines as designated, certain peripheral themes have been suggested as material was collected, as well as from discussions with the many people who have contributed to this document in one way or another. Such themes have been discussed individually and almost parenthetically, in whatever context the subject could be introduced most expediently.

It is to be hoped that the information contained in this report will stimulate amplification and more thorough treatment in the individual presentations upon which public participation so intimately depends. In like manner, it is to be expected that, again through public cooperation, attention will also be drawn to relevant areas which this report has not considered.

PART 1

HISTORY AND ECONOMICS

1.1 Background

At the outset it seems advisable to emphasize that a discussion of sour gas processing plants cannot be easily considered without at least cursory reference to the natural gas industry in toto. Indeed, although the terms of reference for this document apply strictly to the environmental effects of sour gas processing facilities, in discussing these effects at the well-site and throughout the gathering stages the impact upon the surroundings is, generally speaking, common to the entire gas industry. Thus almost all hydrocarbons from underground formations contain some sulfur, predominantly in the form of hydrogen sulfide (H_2S). Hydrogen sulfide is an acidic gas; hence the term "sour gas" will be applied to natural gas containing this constituent in excess of an amount specified as the maximum allowable for home consumption of natural gas. Any gas which is sour must be "sweetened" to bring it within the limits prescribed for hydrogen sulfide content; it is then a "sweet gas". Elemental sulfur obtained from the hydrogen sulfide is the by-product of the sweetening process of natural gas and depending upon economic factors may, at times, be thought of as an involuntary by-product of the natural gas industry. The point to be stressed is that the rate of sulfur production and its attendant consequences can be intimately associated with the demand for natural gas, a demand that can only increase in the foreseeable future.

The association of sulfur with natural gas is also the source of a certain amount of confusion especially when one attempts to extricate the economic and socio-political impact of sour gas facilities from those of the overall gas and oil industry. Consequently it must be understood that certain of the statistics and information to follow represent the gas industry as a whole while other data have fortunately been made available for sour gas processing alone. It is hoped the impact of the natural gas industry and its accompanying sulfur production upon the Alberta environment will be more evident as a result of the following report.

The purpose of this introductory section is to view the subject under consideration from its historic and economic position. To this end a number of figures and tables is inevitable. It is also unavoidable that they may disagree in detail among themslevcs or with other quoted data. If attention is directed at orders of magnitude and the changes in a given set of figures with time a reasonable perspective will be forthcoming regarding the place of the sulfur extraction industry in the economy of the province.

In terms of direct employment at gas processing plants the numbers are small - perhaps five thousand employees among some 150 plants. But this figure also completely ignores the very sizeable secondary employment generated by the oil and gas industry.

1.2 Early History and Conservation Measures

Turner Valley holds a firm and monumental place in Alberta history and legend as the site of what was hoped would be the jumping off point for Alberta's economy. The Turner Valley field had already been delineated in 1914. However, it wasn't until 1924 that Royalite No. 4 penetrated the main resevoir of the Turner Valley field. The result was a product high in natural gasoline, an item in considerable demand at that time. Associated natural gas for the most part was unwanted and flared after passing through well-site separators. As the demand for natural gasoline declined and that for natural gas increased, Royalite decided to build a central plant to process the gas that previously had passed through these well-site separators. Thus, the original Turner Valley plant was established in 1933. At this time a considerable impact upon the environment was tolerated (and indeed this was so until very recently), for no sulfur was recovered at the original plant; it probably vented in the order of 200 long tons per day (LTD) of sulfur to the atmosphere as sulfur dioxide (SO_2).

Crude oil production showed further expansions throughout the 1930's and '40's. Even in the mid-1950's apart from facilities at Acheson, Bonnie Glen, Redwater and Turner Valley, the natural gas produced in conjunction with this crude oil was burned off to the atmosphere in flare stacks. Of course, no summary would be complete without mention of the important discoveries at Devon-Leduc 1947-1951.

In these formative years the industry was small, as was the population of the province. Hence, there was little concern for the effect of the industry upon the environment. The Alberta environment didn't generate the social concern it does today. This was partly because the early gas was relatively sweet and had a negligible amount of salt water associated with it. This formation water was occasionally allowed to run off around the well site with detrimental effect to the vegetation lasting for years. What little control the Energy Resources Conservation Board (then the Oil and Gas Conservation Board)*exercised at that time (1930-'47) was limited by statute to the conservation of oil and natural gas. Naturally as more wells were drilled, pollution problems escalated. With the first sour gas wells at Jumping Pound in 1951 came an increased awareness of a possible air pollution problem. In anticipation of this problem and also as a conservation measure a one-stage Claus sulfur recovery unit of 80% efficiency was installed at the Jumping Pound plant for the recovery of 30 long tons per day (LTD) of sulfur from a designed maximum input of 35 million cubic feet per day (MMCFD) of raw gas.

1.3 History: 1957 to the Present

By 1957-'58 pipeline completions enabled Alberta oil and gas to enter Ontario and U.S. markets. This had a tremendous impact on sulfur production in the following way. While the Shell Jumping Pound plant was based on 3-4% hydrogen sulfide in the raw feed stock, the expanded markets for natural gas and sulfur made it feasible in 1959 and 1961, for the Okotoks and Petrogas Crossfield plants to process raw gas containing 33-34% hydrogen sulfide. Under these conditions the percentage increase in sulfur recovered was greater than the percentage increase of associated marketable natural gas. The result was that sulfur production increased from 45,000 long tons per year in 1957 to 1.3 million long tons per year in 1963 and additionally at the rate of 10% per

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The Petroleum and Natural Gas Conservation Board was established in 1938.

year between 1963 and the beginning of 1967. By the end of 1967 sulfur production stood at 2.2 million long tons per year, almost double the 1963 output. A nearly 30% increase of sulfur production in 1967 was due principally to the commissioning of the Petrogas Plant at Balzac and the Canadian Superior Plant at Harmattan, the latter processing raw gas containing 52% hydrogen sulfide.

A further upsurge in the U.S. economy, coupled with new pipeline outlets to the U.S. midwest, plus increasing concern with pollution abatement in Canada, pushed sulfur production over 3 million long tons per year in 1968 and up to 3.8 million in 1969. By the end of 1971 sulfur production reached 4.5 million tons per year. These data are summarized in Figure 1.1.

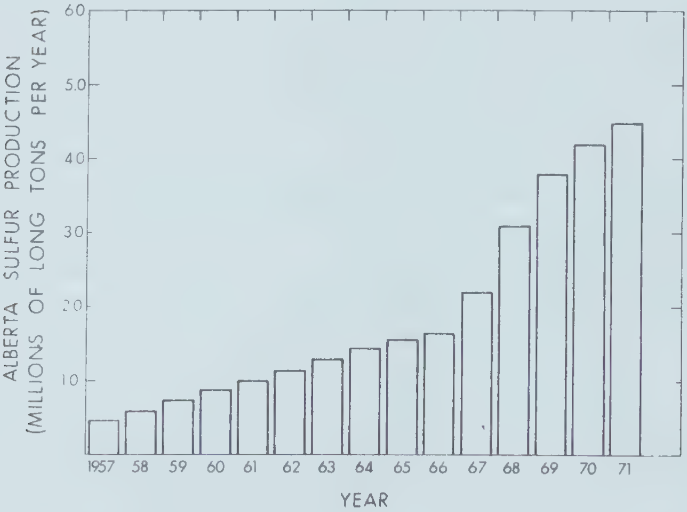

FIGURE 1.1 - ALBERTA SULFUR PRODUCTION IN MILLIONS OF LONG TONS PER YEAR

From three plants processing natural gas in 1947 the industry has expanded to a present 152 plants sixty-seven of which process sour gas (45% of the entire industry). These sixty-seven plants are shown in Figure 1.2. Of these sixty-seven sour gas plants, forty-two are required to recover elemental sulfur as a by-product. The twenty-five plants not required to recover sulfur burn their hydrogen sulfide and release the sulfur to the atmosphere as sulfur dioxide. As of March, 1972, the 152 plants had a total design capacity for processing 12,000 million cubic feet per day of raw gas gathered through 32,000 miles of pipe. From this raw gas 10,000 million cubic feet per day of natural gas could be recovered. In addition these plants were capable of producing 116,000 barrels per day (B/D) of propane, 70,500 barrels per day of butanes, 256,000 barrels per day of pentanes plus and over 24,000 long tons per day of sulfur at an overall average recovery efficiency of 95%.

Here it seems expedient to comment further upon the presentation of the statistics so as to advise the reader regarding figures based upon "designed maximum daily capacity". Maximum plant through-put is never sustained throughout the year, as gas sales are subject to seasonal and in some instances to daily variations, normally being higher in the winter when the demand for natural gas is greater.

1.4 Industry Expenditures in the Province

Totalled from its inception the natural gas industry represents a physical capital investment value of $800 million to the province (Energy Resources Control Board statistic). This is a figure often quoted without comment. While it certainly is impressive as it stands it is also meaningless without that further comment. First of all, as an accumulated figure it represents the sum of all the original plant investment costs plus additions in the current dollars. This is not to deny the sub-contracts let to Canadian and Alberta firms, however. Certainly this job multiplier effect of the sour

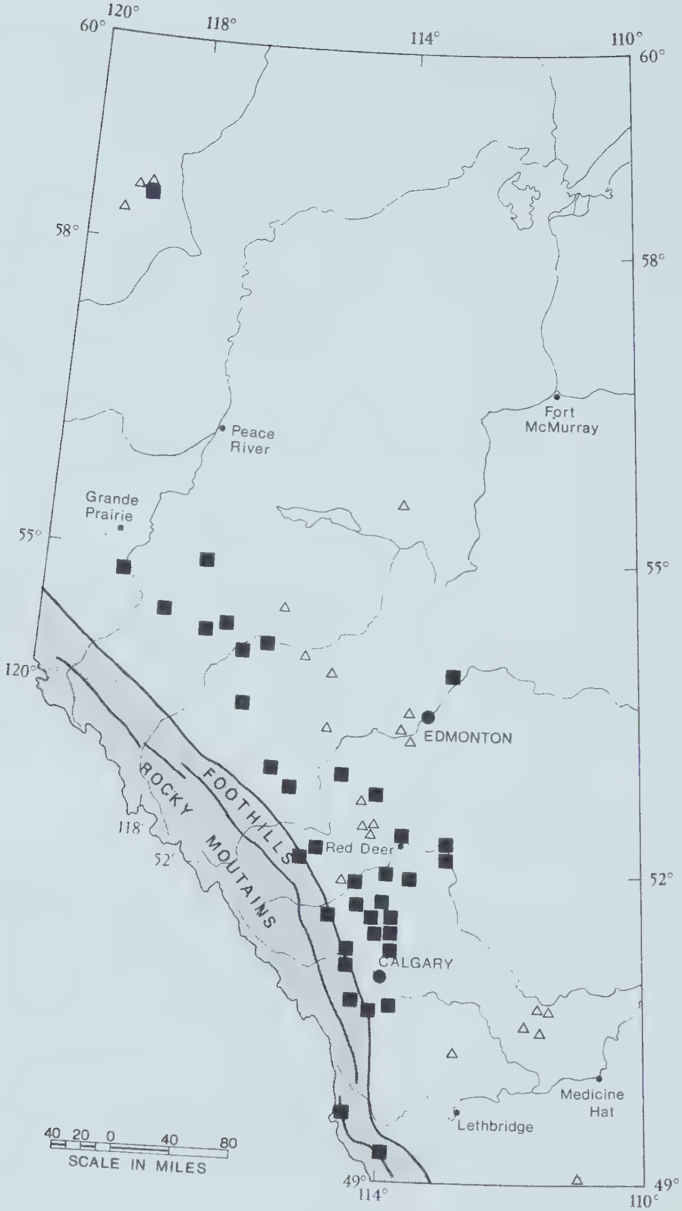

FIGURE 1.2 - LOCATION OF SULFUR EXTRACTION GAS PLANTS IN ALBERTA.

■ Sulfur producing plants

△ Sulfur extraction plants which do not recover sulfur gas industry on our economy has been of inestimable value.

A break-down of other relevant industry expenditures and payments for 1970 and 1972 is given in Table 1.1 as obtained from Oilweek, February 21, 1972.

TABLE 1.1

BREAKDOWN OF INDUSTRY EXPENDITURES IN ALBERTA, MILLIONS OF DOLLARS

	1972 (Predicted)	1970
Exploration	175	163.9
Development	80	63.6
Land	110	106.6
Production Facilities	100	90.3
Production Costs	240	186.7
Gas Plants	105.5	165.7
Royalties	220	156.9
Other	100	89.3
Total	1,130.5	1,023.0

It is no exaggeration to point out that the growth of the province since 1947 has essentially paralleled that of the oil and gas industry.

1.5 Alberta Production in a World-Wide Context

The above statistics take an even broader significance to Albertans when considered in their Canadian and world-wide context. Figures for the past fifteen years show that the primary sources of sulfur in Canada and the world have shifted drastically as a result of the sulfur output associated with the processing of sour gas. Canada changed from a net importer of sulfur in 1960 to become, since 1968, the world's largest exporter of elemental sulfur and in 1971 was second only to the U.S. in total production. As the leading exporter Canada (or more narrowly Alberta, since it is the source of 90% of sulfur exported from Canada) has assumed price influence in this industry, long the perogative of sulfur production in the U.S. based primarily on the Frasch process. Ironically, as a result of intensive marketing efforts and its unique position as a by-product industry, Alberta sulfur can partly be held responsible for the drastic drop in sulfur prices since 1968. Table 1.2 summarized from Oilweek, January 24, 1972, gives the relevant information with the added comment that in July, 1971 a low of $6.41 was being received for a ton of sulfur, f.o.b. Alberta.

TABLE 1.2

VALUE OF CANADIAN SULFUR PRODUCTION

Year	Prodn. (LT)	Sales (LT)	$ Sales Value	$ Price/Ton
1971	4.5 million	2.8 million	21 million	7.50
1970	4.2 million	3.1 million	28 million	8.92
1968	3.0 million	3.3 million	78 million	34.53

While the U.S. is Canada's largest export market (39% of total sulfur sales), the importance of off-shore markets should not be minimized. Sulfur for some of these markets is currently shipped in unitized trains to Vancouver. Transportation costs, particularly for off-shore markets constitute a major factor in the competitive marketing of Alberta sulfur. The latest year for which statistics are available (1970) indicated that loading, transportation and storage costs exceeded the average f.o.b. price to Alberta producers by about one dollar per ton for sulfur marketed off-shore.

1.6 Future Predictions

Obviously the major factor in the world view, as far as Alberta is concerned, is the gap between the supply and demand for sulfur, resulting in rapidly mounting stockpiles and falling prices. The outlook for the future suggests Canada will remain the world's largest exporter; however, world-wide concern over pollution abatement will certainly have its influence in changing somewhat the traditional supply sources.

Anticipating decreasing reserves of natural gas, the National Energy Board announced in November, 1971 that it will not consider future increased export permits for natural gas until domestic needs and supply have been evaluated. The result may be a rise in the price of natural gas and a consequent slackening in demand. Figure 1.3 illustrates these facts in terms of

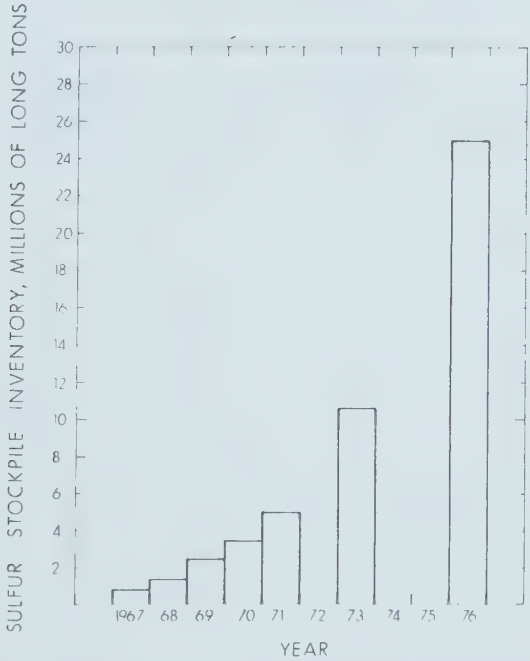

FIGURE 1.3 - ACTUAL AND PROJECTED SULFUR STOCKPILE INVENTORY IN MILLIONS OF LONG TONS (References 7 and 9)

associated sulfur stockpiles. The data include sulfur held at plants, terminals and port facilities. Predictions for the future allow for a 4-5% annual increase in sulfur sales. This annual increase may be compared to the nearly 7% average yearly increase in sales for the late 1960's. Furthermore, it must be pointed out that all predictions of this sort are extremely conditional and should be taken with reservation. They do give an order of magnitude indication of the stockpiling situation.

It is projected that Alberta's share of the sulfur market will likely be on the order of 4 million long tons per year in 1972 which is roughly only one-half of its maximum design capacity. This share may increase to 6 million long tons per year by 1976. Obviously an over-supply is going to exist for some time, given present conditions and projected demands for natural gas.

The value of gas plant construction over the next 3-5 years will probably be less than $100 million simply because no new large fields have been discovered since Ricinus West; and it typically takes four to five years from discovery to bring a plant on stream. Further, the $100 Million will be spent principally in additions and facility upgrading at existing plants rather than construction at new plants.

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PART 2

INTRODUCTION TO PLANT OPERATION

2.1 Structure of the Gas Processing Industry

The structure of the gas industry is peculiar to western Canada. There appears, superficially at least, no high degree of correlation between (a) operating responsibility for a given natural gas processing complex, (b) ownership of the production of the natural gas, liquified petroleum gases (LPG's) or sulfur and (c) the marketing responsibility for the various products. As a consequence various firms may be conducting exploration work on adjoining claim areas and following discovery of a promising petroleum prospect some or all of the companies would commence development work on their own sites with a view to delineating the field. If commercial exploitation seems feasible the field would be "unitized" - all companies (there may be as many as forty) would pool their knowledge of the field and establish a processing unit. The consortium then assigns operating responsibility for the processing unit usually to one of the group of owners. The members usually contribute on the basis of working interests whereby they or their agents dispose of their accredited product, or on the basis of royalty interests, whereby they receive a proportion of the total sales revenue. The growing predominance of huge international petroleum combines in world sulfur is particularly evident in western Canada. In this way owners of sulfur production are by and large subsidiaries controlled by parent groups overseas. For example: Shell Canada Ltd. by Anglo Dutch Shell, Aquitaine Co. of Canada by French Aquitaine Group (S.N.P.A.), Chevron Standard Ltd. by Standard Oil of California.

2.2 Origins of Hydrogen Sulfide

The understanding of the origin of sulfur compounds in crude oil and natural gas is still at an unsatisfactory stage. It seems doubtful that sufficient organic sulfur was present at the time of deposition to account, in all cases, for the quantities of combined sulfur found associated with oil and natural gas. Conjecture suggests anaerobic bacteria could have oxidized hydrocarbons to carbon dioxide (CO_2) using the oxygen in the sulfates sometimes associated with source and reservoir rocks, and in so doing produce hydrogen sulfide. Other studies (Hitchon & Krouse) employing sulfur isotope analyses suggest a combination of physical conditions such as temperature and pressure and lack of oxygen are responsible for the conversion of sulfate to hydrogen sulfide. The amount of hydrogen sulfide found in a given gas field or pool cannot be determined beforehand; it is a function of the environment during deposition, the origin of the particular sediments and their geologic history to the present. Generally speaking the deeper the field the higher the hydrogen sulfide content of the natural gas. It is usually the case that all wells drilled in a given field produce gas of similar composition. However, exceptions can be shown where, for example, the hydrogen sulfide content varies considerably from one end of a field to the other end. In this case the field may contain more than one independent pool or reservoir, from which feed stock is blended to make up the raw gas inlet the plant has been designed for.

2.3 Sour Gas Processing

A given processing facility normally treats gas from only one field, although it is by no means unusual that plant inlet gas be blended from more than one field. The raw gas composition upon which the processing unit operates varies from field to field. Thus one establishment may be confronted with a gas containing 15% carbon dioxide and 0.5% hydrogen sulfide, whereas another must be designed to operate on a sour gas of 55% hydrogen sulfide and 1-2% carbon dioxide. The relative amounts of hydrogen sulfide and carbon dioxide, water vapour and hydrocarbons have a pronounced effect on the design and operation of the plant. All those units indicated schematically in Figure 3.1 exist as a group of physical entities on one site and thus constitute the sour gas processing plant.

Gas processing includes a variety of treatments each designed to suit the gas to be processed. The simplest installations are separators, usually at or near the well, to separate the liquid hydrocarbons and water that condense from the reservoir gas in the well or at the well head. Such installations are not considered gas processing plants today although they were employed as such in the early days of the Turner Valley field; instead they are considered as equipment used in field production.

From the field site to the processing plant the raw gas must be kept near or above 80°F to prevent the formation of pipe-line-plugging, solid compounds between the water and hydrocarbon natural gas. For this purpose in-line heaters are placed at stategic points along the gas line leading into the plant. Water and hydrogen sulfide represents a potentially dangerous corrosive mixture, therefore corrosion inhibitors are also continuously metered into the raw gas stream on its way to the plant. Such compounds presumably adhere as a protective coating to the interior of the pipeline, thus preventing hydrogen sulfide from attacking the pipe wall. These operations are also not normally considered part of gas processing since this gas still needs further treatment in plants capable of producing products to meet standard specifications. It is these more complex installations and equipment that are classified as gas processing plants.

For the sake of completeness and to direct attention to less obvious sources of possible environmental contamination, the origin of which may be placed with sour gas plants, a somewhat detailed analysis of the various unit operations in gas processing follows in Part 3. Such information will also lead to an appreciation of the complex variables plant management faces and can no doubt expect in greater degree as our concern with the quality of the environment deepens.

2.4 Summary of Unit Operations

In some cases, where the hydrogen sulfide content is low, the separated hydrogen sulfide is incinerated. In others, where hydrogen sulfide constitutes a relatively large proportion of the gas, it is recovered and processed to elemental sulfur. In brief, the hydrogen sulfide contained in sour natural gas is absorbed at a sulfur recovery plant located at or near the gas producing field. This absorbed acid gas fraction containing hydrogen sulfide is regenerated and partially burned under controlled conditions. During this combustion process elemental sulfur is released from a vapour containing unreacted hydrogen sulfide. This vapour containing hydrogen sulfide and sulfur dioxide is subsequently passed over a sequence of catalytic converters and condensers where liquid sulfur is formed, collected, and run to storage vats. Any hydrogen sulfide unreacted is then combusted to sulfur dioxide and released through a stack to the atmosphere.

2.5 Constituents Extracted from Natural Gas

The main constituents extracted from natural gas include hydrogen sulfide, which must be removed because it is both corrosive and toxic, carbon dioxide, which lowers the heat value of the gas, and a group of liquid hydrocarbons, so called because of the relative ease with which they may be liquified from a raw gas stream.

The lightest liquid hydrocarbon is propane. The next heaviest of the liquid hydrocarbons are the butanes. These are followed by a group called pentanes plus which contains not only pentanes but varying quantitites of heavier constituents such as hexanes, heptanes, octanes, etc.

Condensate refers to liquid hydrocarbons that condense at the well head, usually in simple separators. Condensate may contain varying amounts of the liquid hydrocarbons referred to in the previous paragraph as well as crude oil.

PART 3

DETAILED PLANT OPERATIONS

3.1 Plant Diagram and Gas Analysis

Figure 3.1 is a simplified flow diagram of the processes which take place in a typical gas processing plant. Table 3.1 presents sample analyses of some of the important gas streams entering, within, and leaving the processing plant. The numbers at the column headings refer to the points of analysis shown in Figure 3.1. It is to be noted that Table 3.1 analyses are on a dry basis, i.e. they overlook the water vapour that is present at concentrations which also depend upon the point of analysis. Furthermore, the calculated compositions are in terms of mole per cent and must therefore be multiplied by 10,000 to convert them to parts per million (ppm) by volume, again on a dry basis. The individual operations designated in Figure 3.1 will now be discussed in some detail.

3.2 Inlet Separation

The inlet separation facilities normally consist of a vertical or horizontal separator into which flow the raw gas, condensate and produced salt water from the field gathering system. Sufficient retention time is provided to allow gravity separation of the three "phases" entering the separator. The gaseous phase is drawn off the top of the separator and flows to the gas sweetening facilites if sour, or directly to the dew-point control facilities if sweet. The hydrocarbon liquid phase (condensate) is drawn off from a mid-point in the separator and directed to the condensate stabilization facilities. The produced salt water is drawn off the bottom of the separator. The water may then be treated in a sour water stripper, if it contains hydrogen sulfide, before being injected through a disposal well to an underground formation. Stripping of the hydrogen sulfide from the water is accomplished using sweet gas or steam in a small column. The hydrogen sulfide stripped from the water should not be vented to the atmosphere, as it represents a potential source of pollution, but is generally directed either

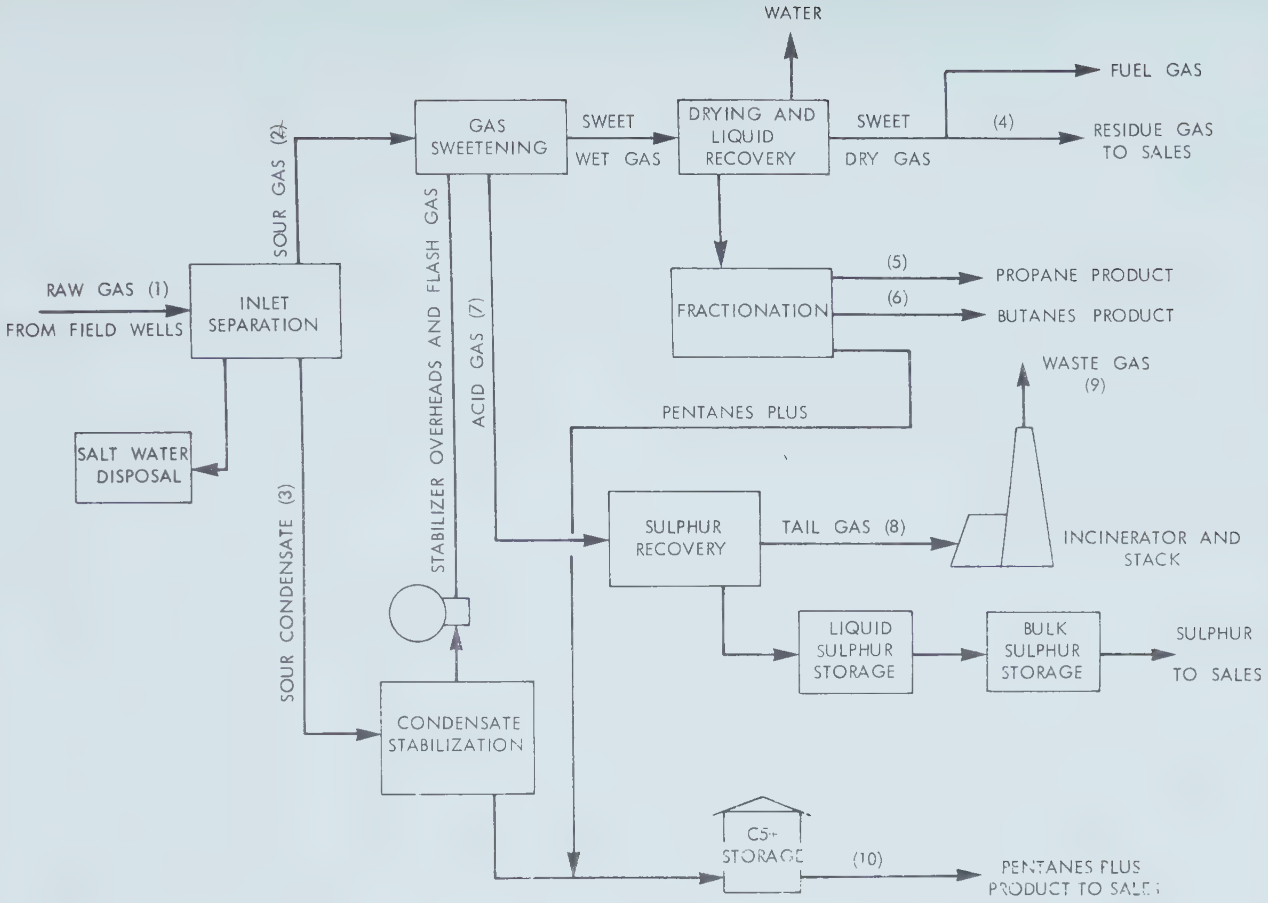

FIGURE 3.1 - SIMPLIFIED FLOW DIAGRAM OF A GAS PROCESSING PLANT. (Reference 1)

TABLE 3.1

EXAMPLE GAS COMPOSITIONS*

(MOLE %)

Compenent	Symbol	1 Raw Gas	2 Sour Gas	3 Sour Con-densate	4 Sales Gas	5 Propane Product	6 Butanes Product	7 Acid Gas	8 Tail Gas	9 Stack Gas	10 Pentanes Plus
Nitrogen	N_2	0.94	1.08	Tr	1.33	----	----	----	85.52	87.47	----
Methane	C_1	65.66	73.78	11.90	92.93	----	----	1.37	----	----	----
Ethane	C_2	3.59	3.40	4.62	5.16	2.99	----	0.19	----	----	----
Propane	C_3	1.25	0.84	3.71	0.58	96.09	1.05	0.10	----	----	0.05
Isobutane	iC_4	0.29	0.14	0.45	----	0.90	32.14	0.06	----	----	0.39
Normal Butane	nC_4	0.74	0.28	3.91	----	----	65.76	0.09	----	----	3.29
Pentanes	C_5	0.79	0.10	5.66	----	----	1.05	----	----	----	13.31
Hexanes	C_6	0.90	Tr	7.20	----	----	----	----	----	----	15.61
Heptanes Plus	C_7^+	3.88	----	32.96	----	----	----	----	----	----	67.32
Hydrogen Sulphide	H_2S	17.66	15.93	27.55	----	----	----	76.94	1.84	----	0.04
Carbon Dioxide	CO_2	4.30	4.45	2.04	----	----	----	17.89	10.86	7.30	----
Sulphur Dioxide	SO_2	----	----	----	----	----	----	----	0.75	1.73	----
Carbon Disulphide	CS_2	----	----	----	----	----	----	----	0.41	----	----
Carbonyl Sulphide	COS	----	----	----	----	----	----	----	0.62	----	----
Sulphur Vapour	Sv	----	----	----	----	----	----	----	Tr	----	----
Sulphur Liquid	S_1	----	----	----	----	----	----	----	Tr	----	----
Oxygen	O_2	----	----	----	----	----	----	----	----	3.50	----
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

*Analyses are example analyses only and do not represent a material balance about the plant back to the plant for further processing, to a flare or to the sulfur plant incinerator.

3.3 Gas Sweetening Facilities

Reversible selective absorption in an aqueous solution of an amine is the most common method used in Alberta to remove acid gas (hydrogen sulfide and carbon dioxide) from raw gas streams. Transfer of the acid gas from the raw gas takes place as cool, lean (pure) amine solution flowing counter-currently downward in a scrubbing tower is contacted with the gas. The acid gas absorption into the solvent is directly proportional to the pressure, consequently the pressure in these contactors ranges from 400-900 pounds per square inch gauge (psig), depending upon the desired hydrogen sulfide content of the resultant sweetened gas leaving the top of the tower. The hydrogen sulfide and carbon dioxide are stripped from the rich amine (hydrogen sulfide, carbon dioxide saturated) when it is heated under decreased pressure (5-10 psig) in a solvent regenerator. The regenerated amine solution is then ready for another cycle after being cooled.

The treating solutions most commonly used are mono-ethanolamine (MEA), di-ethanolamine (DEA) and Sulfinol, a mixture of di-isopropanolamine (DIPA) and sulfolane. The choice of solutions depends to some extent upon the ratio of hydrogen sulfide to carbon dioxide in the raw gas and also upon a variety of other considerations which need not be discussed here. Although the typical gas analysis (Table 3.1) did not so indicate, some sour gases contain carbonyl sulfide (COS) and carbon disulfide (CS_2) as part of their total sulfur value. MEA and DEA will generally remove these compounds without degradation of the solvent, but will not easily regenerate them. Hence they will accumulate through the cycle. Sulfinol, used in the case of very high acid gas content, also is quoted as removing carbonyl sulfide and carbon dioxide without degradation of the solvent. Its disadvantage is its affinity for heavy hydrocarbons (C_4+) and aromatics which would carry over with the hydrogen sulfide and carbon dioxide to the Claus unit (described below) and result in a poor quality of sulfur.

All these chemicals are circulated in a water solution. In an MEA treating plant the treating solution is normally from 15% to 20% MEA and from 85% to 80% water. In a DEA treating plant the treating solution is normally from 25% to 30% DEA with the remainder water. In a Sulfinol plant the treating solution is normally 45% DIPA, 35% sulfolane and 20% water.

The wet acid gases, regenerated as described above, are cooled, condensed water (H_2O) is separated in a reflux accumulator and the acid gas is directed to the sulfur plant at 5-10 psig.

A diatomaceous earth filter system is normally required to remove corrosion products and other intractable compounds from the amine solution. In addition a rich amine solution flash tank is sometimes installed to remove absorbed hydrocarbons from the rich MEA or DEA solution prior to regeneration of the acid gases.

Other sweetening processes are available and are described in the references listed for this section.

3.4 Sulfur Recovery

The acid gas (hydrogen sulfide and carbon dioxide) from the gas sweetening plant is directed to the sulfur recovery plant where elemental sulfur is recovered from the hydrogen sulfide contained in the gas using the Claus process, named after its inventor. There have been modifications to the Claus process from time to time and from plant to plant, but the process is basically as outlined below.

The acid gas enters a free flame combustion furnance at 1700-2200°F where the hydrogen sulfide is burned in a deficiency of oxygen (air). This step is necessary in order to produce sufficient sulfur dioxide for a subsequent more efficient catalytic reaction between sulfur dioxide and unreacted hydrogen sulfide, which yields additional elemental sulfur. The ratio of air to hydrogen sulfide and the residence time of the gases in the furnace must be very carefully regulated so that the following reactions occur in the proper proportions:

$$2H_2S + 3O_2 \rightleftharpoons 2SO_2 + 2H_2O \qquad (3.1)$$

$$2H_2S + O_2 \rightleftharpoons 2S + 2H_2O \qquad (3.2)$$

$$2H_2S + SO_2 \rightleftharpoons 3S + 2H_2O \qquad (3.3)$$

Reactions (3.2) and (3.3) imply sulfur is also formed in this partial combustion process, and indeed approximately 50% of the conversion of hydrogen sulfide to sulfur is accounted for in this way. In practice the chemistry is not quite as simple or completely understood as indicated by equations (3.1) to (3.3) because the gas leaving the front end furnace contains hydrogen (H_2), carbonyl sulfide, carbon disulfide, and by inference sulfur trioxide (SO_3) as well as the products indicated in the above equations.

The hot gas stream leaving the reactions furnace is then cooled in the first sulfur condenser to condense most of the sulfur vapour formed in the furnace. In order to promote a further reaction between sulfur dioxide and hydrogen sulfide to form more sulfur, the gas stream leaving the first condenser enters the first catalytic converter after being preheated with either hot gas from the reaction furnace or an in-line burner. The catalysts normally employed in the converters to catalyze sulfur production are naturally occuring bauxite, or activated alumina. The choice of catalyst and duration over which it maintains its activity, or efficiency, varies depending on the gas composition entering the Claus unit.

The sulfur vapour formed in the catalytic converter is subsequently condensed in the second condenser and removed from the gas stream. This process is repeated for up to a total of four stages of catalytic conversion. Typical recovery percentages have been calculated for various acid gas feed concentrations of hydrogen sulfide from 20-90% for two, three and four reactors, Table 3.2 and Figure 3.2

TABLE 3.2

TYPICAL CLAUS PLANT SULFUR RECOVERY FOR VARIOUS FEED COMPOSITIONS WITH NORMAL ORGANIC CARRY-OVER AND ENTRAINMENT ALLOWANCE
(Reference 3)

Hydrogen sulfide in sulfur plant feed (dry basis) %	Two Reactors	Three Reactors	Four Reactors
20	92.7	93.8	95.0
30	93.1	94.4	95.7
40	93.5	94.8	96.1
50	93.9	95.3	96.5
60	94.4	95.7	96.7
70	94.7	96.1	96.8
80	95.0	96.4	97.0
90	95.3	96.6	97.1

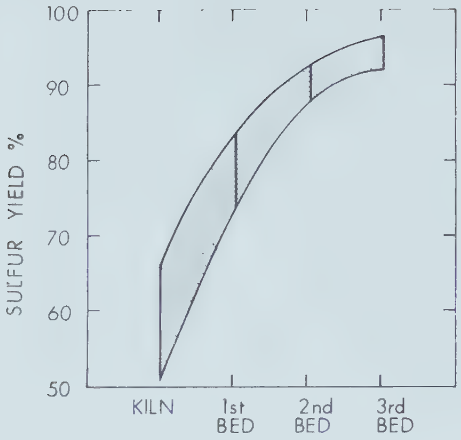

FIGURE 3.2 - PERCENT SULFUR RECOVERED IN CLAUS PLANTS AS A FUNCTION OF THE NUMBER OF CLAUS CONVERTERS, ASSUMING 1 MOLE PERCENT HYDROCARBON CONTAMINATION AND CATALYST TEMPERATURES OF 400-500°F. (Reference 4).

These calculations assume one mole percent hydrocarbon contamination and conventional catalyst temperatures of 400-500°F.

It must be appreciated that chemical reaction(3.3) is a reversible reaction, i.e. it can occur in both directions. As a result, complete conversion to sulfur and water can never occur since sufficient water and sulfur vapor are always present to limit conversion. Additionally, carbon dioxide, water vapor and nitrogen in the feed stock shift the Claus equilibrium adversely. Hydrocarbons and carbon dioxide cause great difficulty by increasing undesirable side reactions,forming carbonyl sulfide and carbon disulfide which are difficult to convert to elemental sulfur. As little as five gallons of hydrocarbon and/or amine carried over to the Claus unit per million standard cubic feet of gas processed (in the order of 80 parts per million) can also cause production of dark, impure, off-coloured sulfur. Some plants have had success in using a cobalt-molybdenum catalyst in the first converter to transmute carbonyl sulfide and carbon disulfide to sulfur.

The reaction between sulfur dioxide and hydrogen sulfide to form sulfur (reaction (3.3)) is exothermic (librates heat), hence lower temperatures favor the formation of sulfur in the catalyst converters. The lower practical limit here is that temperature which maintains the sulfur as a vapor (400-500^{O}F).

The lower practical temperature for the sulfur condensing steps is set at 260^{O}F by the solidification of the sulfur product and plugging of the apparatus. A further temperature limitation is established at the point where water condenses. Hydrogen sulfide and sulfur dioxide in the presence of liquid water react to form complex polythionic acids ($H_2 S_x O_3$) known as Wackenroder's solution. This solution is extremely corrosive to all known construction metals with the possible exception of titantium.

3.4.1 Operating Limitations

In summary then, a sulfur recovery unit as presently designed never matches its theoretical performance due to the following factors:

(1) Decline in catalyst activity;
(2) Side reactions involving loss of sulfur;
(3) Entrained sulfur mist in condenser outlets;
(4) Exact air and gas ratio control is never continuously achieved, even with the most sophisticated instrumentation;
(5) Results on carefully operated plants indicated 0.5-1 percent below theoretical recovery rate after initial start up and this will decline about 0.5 percent more before the catalyst is replaced because of deactivation. These conclusions are included in Figure 3.2, but not in Table 3.2.

3.5 Incineration

Finally, the gas leaving the last condenser flows through a coalescer which removes fine droplets of liquid sulfur entrained in the gas stream. The gas stream then flows to the incinerator. In the incinerator sufficient fuel gas and air are added to completely oxidize any unrecovered sulfur in the form of hydrogen sulfide, entrained sulfur liquid, sulfur vapor, carbonyl sulfide and carbon disulfide (these latter two may be formed in the reaction furnace due to the presence of carbon dioxide and trace amounts hydrocarbons in the acid gas stream) to sulfur dioxide. The gas stream leaving the incinerator then flows to the stack for dispersal to the atmosphere. The stack is designed to discharge the sulfur dioxide to the atmosphere at a sufficiently high velocity, to a sufficient height and at a sufficiently high temperature (normally 1000^{0}F) so that the sulfur dioxide will disperse to a concentration which will not result in a hazard to vegetation, human or animal life, when it settles to the ground.

It should be noted from Table 3.1 that the stack gases normally contain from one to two percent sulfur dioxide. The remainder is primarily nitrogen, from the air added to the sulfur plant reaction furnace and to the incinerator, carbon dioxide from the acid gas and carbon dioxide formed due to the burning of fuel gas in the incinerator. There also should be excess oxygen present to ensure that all combustible sulfur compounds are fully oxidized to sulfur dioxide. Considerable water vapour, which is a product of the various combustion reactions which take place in the sulfur plant and in the incinerator, is also present in the stack gas.

3.6 Elemental Sulfur

The recoverable sulfur product flows into a heated underground pit and after gauging is either pumped to tank cars, or is cast into large blocks and stored in the open. Considerable experimental work is being done with pelletized and slated forms of solid sulfur to avoid the sulfur dust problem associated with cast solid sulfur. An Alberta company is presently the world leader in equipment designed for slating and handling of slated sulfur.

3.7 Heat Generation

Large amounts of heat are generated by the various exothermic reactions which take place in the sulfur plant reaction furnace and catalytic converters. A part of this heat is recovered in the reaction furnace waste heat boiler and in the sulfur condensers where it is used to either preheat boiler feedwater or generate steam. This steam is normally used throughout the rest of the plant for process heat requirements and to drive process pumps, compressors, etc. For this reason many of the plants processing highly sour gas with considerable steam generation are dependent on the operation of the sulfur plant for steam required in the remainder of the plant.

3.8 Determination of the Efficiency of Sulfur Recovery Plants

Some of the methods presently applied to determine plant input and sulfur recovery are not compatible with present trends in air quality requirements. In order to establish sulfur recovery efficiency, it is assumed that one must be able to determine a minimum of two of the following three parameters: (1) sulfur input; (2) sulfur production; (3) sulfur emissions.

Sulfur input is deduced from measurements of acid gas flow rates from the field as found from orifice flow meters (accurate to ± 2%). In the case of large plants this could entail the reading of up to twenty flow meters. The wet chemical Tutwiler method of sulfur analysis is potentially accurate to ± 1%. The more refined gas-chromatographic method of sulfur analysis, as of this date, has been employed by the newer and larger plants, some only on a spot check basis. It is fast, accurate to ± 1% and capable of integration with computerized monitoring of plant operation.

Sulfur produced from a Claus plant is held as a liquid in a heated pit where daily production is checked with a floating pit gauge. The measurement of sulfur produced as found from pit gauge is perhaps the area where least accuracy will be encountered.

In the past the Department of the Environment (previously the Department of Health) made standard incinerator stack surveys involving measurement of gas flow velocity profiles followed by wet chemical analysis for sulfur dioxide.

This was a tedious and unappealing manual operation carried out at upwards to 150 feet up the stack. It is obvious why it wasn't done on a routine basis. With the advent of gas chromatographic techniques, and infrared and ultraviolet analysis procedures, it has been feasible to operate continuous stack surveys of sulfur dioxide, and in some cases to ascertain whether other sulfur compounds also contribute to lost sulfur values. Since the amount of sulfur unconverted and incinerated is a small percentage of the sulfur fed to the Claus plant, errors as large as ± 5% in such measurements would contribute little error to the calculated sulfur plant efficiency.

It is therefore feasible, and in fact is practiced at the large plants, that sulfur recovery efficiency be based upon assessment of sulfur input (determined as the sum of sulfur produced, sulfur emitted as sulfur dioxide, and sulfur contained in the condensate and pentanes plus fractions) and sulfur lost (sulfur emitted through the stack and sulfur in the condensate). This should afford an accuracy of about one percent in evaluating the sulfur recovery efficiency using an expression of the form

$$\text{Percent Sulfur Recovered} = 100\left(1 - \frac{\text{Sulfur lost}}{\text{Sulfur input}}\right) \qquad (3.4)$$

Some plants have found it useful to evaluate the amount of hydrogen sulfide, sulfur dioxide, carbonyl sulfide and carbon disulfide in the tail gas prior to incineration. While this is useful information which may be used to regulate plant operation, as a method of defining sulfur productivity it overlooks possible entrained sulfur vapor which would be converted to sulfur dioxide in the incinerator.

3.9 Sweet Gas Treatment

To re-affirm the two-product nature of the sour gas treatment facility and to draw attention to the difficulty in dealing solely with a sulfur producing operation in any discussion of the environmental effects of the latter, we must consider here the procedures needed to prepare the sweet gas for market. They occur at the same location as do those of sulfur recovery and involve chemicals and waste material disposal which cannot be overlooked.

3.9.1 Drying and Liquid Recovery

Sweet gas leaving the gas sweetening facilities is water saturated and may contain appreciable quantities of recoverable propane, butanes and some pentanes plus. The water contained in the gas must be removed before the gas is sold and the operator may also wish to install facilities to recover the LPG's (liquified petroleum gases) and pentanes plus.

Even if no liquid hydrocarbon recovery is planned facilities are provided for drying the gas. These facilities normally consist of either desiccant drying towers or glycol contacting facilities.

3.9.1.1 Dry Desiccant Drying

A desiccant drying system normally consists of two or more parallel columns containing desiccant pellets (silica-gel or some other silicon-oxide based material) through which the gas is passed. Water contained in the gas is adsorbed by the porous desiccant material. The drying towers are normally operated on a timed cycle. One tower may be used for adsorption while a second is being regenerated (with hot dry gas) and a third is being cooled following regeneration. The gas flows are switched from tower to tower at the end of each timed cycle by automatically controlled switching valves. Water is removed from the regeneration gas stream by cooling the regeneration gas to below its water dew point.

3.9.1.2 Glycol Drying System

In a glycol drying system the wet gas stream flows upward through a trayed column and is contacted by a countercurrent flow of lean glycol (normally tri-ethylene glycol). The glycol absorbs the water contained in the gas. The glycol leaving the contactor is regenerated with heat and pumped back to the contactor. Water removed from the glycol during regeneration is normally vented to the atmosphere as a vapour.

If liquid hydrocarbons are to be recovered from the gas stream the water removal and liquid hydrocarbon removal processes normally take place simultaneously. In some plants desiccant towers are used for the removal of both water and liquifiable hydrocarbons. In most plants however, either a refrigeration or a refrigerated absorption process is used.

3.9.1.3 Refrigeration Process

In a refrigeration plant the gas stream is cooled through heat exchange with a refrigerant (normally boiling propane) to liquefy the water and heavier hydrocarbons. Ethylene glycol is injected into the gas prior to refrigeration to prevent the formation of hydrates during the cooling. The water-glycol and liquid hydrocarbon phases are then removed separately from the dry residue gas stream in a low temperature separator. The recovered liquid hydrocarbons then either flow to the fractionation facilities for separate recovery of propane, butanes and pentanes plus or following a stabilization procedure, flow to the pentanes plus storage tanks if they contain only small amounts of propane and butanes. The amount of pentanes plus produced in this manner is normally small compared to the amount produced from the condensate stabilization facilities. In certain cases the LPG - pentanes plus mix is not fractionated but is sold as a mixed LPG product. This is the situation at the new Imperial Oil Quirk Creek Plant.

3.9.1.4 Refrigerated Absorption Process

If "deep-cut" LPG recovery is required the gas from the low temperature separator flows through a low temperature absorber where it is contacted countercurrently with a refrigerated low molecular weight absorption oil. The oil absorbs any liquefiable gases remaining in the dry residue gas stream. The gas stream leaving the absorber then goes to sales. The rich oil is regenerated first in a rich oil de-ethanizer (absorbed ethane and methane are removed) and then in a rich oil still where the absorbed LPG's are removed and directed to the fractionation facilities. The regenerated lean oil is then refrigerated and returned to the absorber.

The glycol injected into the wet gas stream prior to refrigeration is recovered in the low temperature separator with the water and is regenerated in the glycol regeneration facilities.

3.9.2 Fractionation

Mixed liquiefiable hydrocarbon gases from the refrigeration plant are directed to the fractionation plant for separation to propane, butane and pentanes plus. This separation is accomplished in a series of fractionation columns, each containing several trays. The feed to each column enters at approximately the mid-point. The operating pressure and temperatures of the columns are such that the lightest hydrocarbon in the feed is removed from the top of each column as a vapour and the heavier hydrocarbons are removed from the bottom in the liquid phase. Heat is added to each column at the bottom using a reboiler and heat is extracted at the top using an overhead condenser. In this manner the bottom temperature is held higher than the top temperature.

3.9.3 Condensate Stabilization

Raw condensate from the inlet separator flows to the condensate stabilization facilities. From the analysis of stream 3 in Table 3.1, it can be seen that this condensate can contain a considerable amount of light hydrocarbons and acid gases. The condensate stabilization facilities are provided to remove these light hydrocarbons and acid gases from the condensate in the production of a stabilized pentanes plus product. The presence of large quantities of the gases in the pentanes plus product would result in a considerable loss of sour hydrocarbon vapours to the atmosphere from the pentanes plus storage tanks and a resultant pollution and personnel safety problem.

The condensate from the inlet separator therefore is stabilized by first "flashing" it at a low pressure in a condensate flash tank and then by heating it and feeding it to a low pressure condensate stabilizer column. This column fractionates the lighter components and much of the hydrogen sulfide and carbon dioxide from the final pentanes plus product. The vapours removed from the condensate are normally compressed and sweetened in the gas treating plant.

The pentanes plus product is normally stored in atmospheric pressure storage tanks before delivery through a pipeline to a refinery for further processing.

3.9.4 Small Gas Processing Plants

In many cases processing plants do not recover all the products mentioned above. In these cases the process employed is greatly simplified.

3.9.5 Pipeline Extraction Plants

Four pipeline straddle plants operate in the Province (two near Empress, one near Cochrane and one in Edmonton). These plants process pipeline natural gas for the recovery of LPG's. All four plants use a refrigerated oil absorption process to recover these LPG's.

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PART 4

REGULATORY AGENCIES GOVERNING THE OPERATIONS ASSOCIATED WITH PROCESSING PLANTS

4.1 General

A broad collection of regulations and guidelines already circumscribe allowable practices appropriate for the gas processing industry. The current concern with environmental issues keeps these guidelines constantly under governmental review. In spite of this fact occasional public forums such as that anticipated in the present instance do provide an often necessary degree of intensity to such reviews.

Thus, while it may be of value to catalogue here the existing regulations pertinent to sour gas processing, we are also aware that these standards are constantly under review and up-dated in keeping with technological advances in the industry. Not only are the industry's codes being revised but also the monitoring and enforcement capabilities of the responsible private and governmental agencies have been improved in quantity and sophistication. The increasing number of deleterious compounds for which the Department of the Environment exercises state-of-the-art detection facilities should also assist in assuring the public that their concern has been noted and that scientists are acting upon their inherent concern for the welfare of the province.

4.2 Statutory Responsibility for Regulation of the Gas Industry

In 1970, through amendments to the Oil and Gas Conservation Act, the Oil and Gas Conservation Board was assigned responsibility to control pollution in oil and gas field operations. During 1971 the legislature of Alberta, by passing the Energy Resources Conservation Act and the Hydro and Electric Energy Act, consolidated Energy Resource Management within the Energy Resources Conservation Board. Furthermore, it charged the Board to broadly manage energy matters in balance with other environmental matters. Also during the 1971 session of the legislature, the Department of The Environment Act was passed and this was complemented with the Clean Air Act and the Clean Water Act. The Department of The Environment Act not only established the Department but also granted the Minister responsibilities and duties in connection with environmental matters.

Environmental matters were defined as those legal or economic factors and any operations or activities which directly or indirectly affect the quality or quantity of any natural resource in the various phases of resource utilization, with specific emphasis on the prevention of degradation or pollution of those resources.

Specifically, the Minister was charged with the co-ordination of policies, programs, services, and administrative procedures of all government Departments and agencies, in matters pertaining to the environment. The Clean Air and Clean Water Acts both give the Minister the responsibility of setting maximum permissible levels of pollutants and the approval of all plans and specifications to ensure that these standards are not exceeded, as well as the setting of emission control standards and the halting of any operation or activity exceeding these standards.

The 1972 legislative amendments to several statures, including the Oil and Gas Conservation Act and recently agreed upon administrative procedures, confirmed the Board's general role as defined earlier in 1970 but made it clear that regulations and conditions of approvals affecting environmental matters are now subject to the approval of the Department of The Environment. The present situation, therefore, is that overall responsibility for pollution control is consolidated within the Department of The Environment.

In oil and gas operations, the Energy Resources Conservation Board, in effect, is delegated responsibility for devising and administering the ways and means required to ensure that the standards are met. This means devising conditions of approval, devising the regulations subject to the Department of the Environment's approval and taking corrective action where required. It also means that the Board will continue to be the principal communication link with the industry on pollution control matters.

Table 4.1 outlines current division of responsibilities for those matters of direct concern to the Board, the Departments of Environment, Lands and Forests, Mines and Minerals, and Agriculture. The Department of The Environment sets province wide air quality, water quality, surface and groundwater use, and watershed protection standards criteria. The Boards role with respect to control of pollution of surface and groundwater is to enforce its prohibition of the disposal of hydrocarbons, produced water or other field wastes to any body of surface water, and to enforce regulations to protect domestic sources of groundwater from pollution or depletion by the oil and gas industry. Proper housekeeping at well and battery sites during drilling operations and producing operations is the responsibility of the Board. Final reclamation of abandoned sites in the unsurveyed areas is administered by the Department of Lands and Forests as provided in the surface lease. Abandonment and reclamation of sites on other lands are administered by the Department of the Environment. The sale of oil and gas leases is administered by the Department of Mines and Minerals. The Boards pipeline division oversees the approval and testing of pipelines and the cleanup of oil spills resulting from pipeline breaks. The Department of The Environment and Lands and Forests approve the location of pipelines and advise on specifications for river crossings.

The co-ordination of these activities is the responsibility of the Department of The Environment. The Minister of the Department of The Environment may issue stop orders where necessary to protect the environment.

TABLE 4.1

OIL AND GAS INDUSTRY ENVIRONMENT CONTROL RESPONSIBILITY

(Reference 1)

ENVIRONMENT ELEMENT	ENERGY RESOURCES CONSERVATION BOARD RESPONSIBILITY	DEPT. OF THE ENVIRONMENT RESPONSIBILITY	DEPT. OF LANDS & FORESTS RESPONSIBILITY	DEPT. OF MINES & MINERALS RESPONSIBILITY
1. Air	1. enforce air quality standards in oil and gas industry.	1. set air quality standards for the province. 2. enforce air quality standards (except oil and gas, coal and electric power industries).		
2. Surface Water	1. prohibit disposal of hydrocarbons, produced water, and other oil-field wastes to surface water. 2. request government forces to clean up catastrophic oil spills.	1. control use of surface water. 2. set, monitor and enforce water quality standards. 3. set, monitor and enforce effluent waste quality.	1. enforce Federal fish and game bird acts pertaining to water pollution. 2. co-ordinate and assist fire fighting force to clean up catastrophic oil spills.	

(cont'd)

ENVIRONMENT ELEMENT	ENERGY RESOURCES CONSERVATION BOARD RESPONSIBILITY	DEPT. OF THE ENVIRONMENT RESPONSIBILITY	DEPT. OF LANDS & FORESTS RESPONSIBILITY	DEPT. OF MINES & MINERALS RESPONSIBILITY
3. Subsurface Water	1. protect domestic groundwater from pollution or depletion by oil and gas industry.	1. administer use of groundwater for non-domestic purposes.		
4. Land	1. control disposition of oil and gas industry waste material to surface.	1. enforce reclamation of land surface affected by industry operations.	1. issue surface lease.	1. mineral sales.
	2. enforce good housekeeping in oil and gas industry operations.		2. enforce reclamation of land surface affected by industry operations on unsurveyed lands.	
	3. supervise clean-up of non-catastrophic oil spills.		3. co-ordinate clean up of catastrophic oil spills.	

The Energy Resources Conservation Board has five field offices throughout the province to carry out field inspections. Total field office staff at June 30, 1972 is 71, with 32 in Edmonton, 17 in Red Deer, 8 in Drayton Valley, 7 in Black Diamond and 7 in Medicine Hat. This field staff is made up of 5 engineers, 45 technicians, 8 pipeline inspectors, 5 summer employees (students) and 8 typists, stenos and clerks. There are one or two gas processing plant specialists in each field office but other field office personnel may carry out gas plant inspection work when required. In addition to the field staff, three Calgary based people are working on gas plant stack surveys during the summer and approximately eight additional Calgary based personnel may become directly involved in gas plant inspections and pollution investigations in special circumstances. Funds for that portion of the Board's responsibilities which apply to the oil and gas industry are provided by the provincial government and the oil and gas industry on an equal share basis.

The Board maintains a close liaison with the Canadian Petroleum Association, the Independent Petroleum Association of Canada and the Canadian Association of Oil Well Drilling Contractors. Committees from these agencies work with the Board in arriving at reasonable regulations. Public participation takes place only at hearings in consideration of individual gas processing applications.

Regulations are enforced through monthly surveillance of company reports, field inspections and in answer to specific complaints brought to its attention. All Board regulations are subject to change and hence are a function of time. Stricter regulations and control procedures have already been announced to the industry for the immediate future. Therefore, complaints made against the industry must be considered in terms of the constraints applied to the industry at the time of the complaint. It would appear that reported incidents of infractions, at one time quiescent, went through a peak and now are again relatively few, due in measure to tighter strictures upon the industry, arising out of these earlier incidents.

The day-to-day involvement of the Board and the Department of the Environment with the industry is through the issuance of regular 'Information Letters' on the part of the Energy Resources Conservation Board and "Air Monitoring Directives" by the Department of the Environment Pollution Control Division, examples of which are cited in the references for this section.

In addition, there is the basic legislation embodied in the Clean Air Act, the Ambient Air Quality Standards of Alberta and the provisions of the Oil and Gas Conservation Regulations which the Board is bound to enforce. The Ambient Air Quality standards are attached to this report as Appendix I.

4.3 Regulations by Contaminant

The following specific operating standards are enforced by the Board to ensure achievement of the objectives as embodied in the above legislation:

Oil - Disposal of waste oil is permitted only in limited amounts and it must be contained. Pit storage is prohibited and flaring must be smokeless.

Gas - Disposal as a waste is permitted in limited amounts where no practical means of conserving the gas exists. Disposal must be through smokeless incineration.

Sour Gas - No venting of hydrogen sulfide without conversion to sulfur dioxide. Venting of sulfur dioxide must be such that calculated ground level concentrations averaged over a one-half hour period, are maintained at or below 0.2 part per million in populated or agricultural areas or 0.3 part per million in all other areas.

Gas Processing Odors - Limited so that no odor complaints arise from nearby residents.

Drilling Mud - Appropriate on-lease disposal is permitted but no off-lease disposal except to approved locations.

Salt Water - No surface disposal is permitted except to approved storage pits in amounts of less than 100 barrels per month per pit. All other disposal must be to underground formations in accordance with schemes approved by the Board.

Smoke - Essentially no visible smoke is permitted from the burning of hydrocarbons.

4.4 Regulation by Operation

4.4.1 The Battery

A battery (a gathering point for treating collectively the fluids from a number of wells) processing oil, salt water and sour gas presents hazards from all the major pollutants present in the industry. The regulations are designed to minimize spills and leaks from processing equipment. Disposal of waste products is controlled to prevent pollution of soil, air or water.

Approval of the location and design of a battery must be obtained prior to construction if the gas contains more than one per cent hydrogen sulfide.

1. The operator is required to gather solution gas where it is economically feasible to do so. Where sour gas production results in a potentially serious pollution problem, gathering may be

required even though it cannot be justified on economic grounds.

2. Relief valves from pressure vessels must be piped to a tank to prevent oil from spraying over the lease.
3. Sour tank vapours from oil or salt water tanks must be collected and flared through an elevated stack.
4. Dikes must be constructed around storage tanks. If the battery is close to lakes or streams another dike surrounding the battery is required.
5. Where sour solution gas is not gathered, it must be flared through a stack of sufficient height to ensure that half hour maximum ground level concentrations of sulfur dioxide are below 0.2 part per million.
6. Storage of salt water in earthen pits is limited to 100 barrels per month. Subsurface disposal of salt water is encouraged.

4.4.2 Gas Processing and Sulfur Recovery Plants

Gas processing and sulfur recovery schemes must be approved by the Board prior to any construction related to the scheme. In instances where the gas is to be processed for the removal of hydrogen sulfide an application for approval must be considered at a public hearing or a notice of the application must be published so that objections may be filed with the Board.

The regulations describe in detail the information needed in support of an application for approval of a new gas processing scheme. With respect to pollution control, the main items required are evidence in support of the proposed sulfur recovery level, a discussion of the reasons for the choice of the plant location, evidence that the main emission and emergency flare stacks have been designed to maintain the maximum half-hour average ground level concentration of sulfur dioxide within acceptable limits, detail respecting the proposed air quality monitoring system, the proposed methods for control of hydrocarbon vapors and sulfur dust, and proposals respecting disposal of produced and process water.

Operators of processing plants treating gas for removal of water are required to report monthly to the Board certain operating data including daily volume of sulfur emitted to the atmosphere as sulfur dioxide. Where the daily emissions of sulfur exceed the quantities approved by the Board, the operator is required to immediately correct the situation. This places day to day responsibility for adherence to emission standards directly with the operator of the plant, because the sulfur recovery efficiencies required of gas processing plants are normally enforced over three month periods and therefore represent three month average recoveries. The sulfur recovery on any one day may be considerably less than that required as a three month average. The daily operations of the plants are controlled primarily through sulfur dioxide emission limitations and in some cases through continuous atmospheric monitoring.

Recent amendments to the Oil and Gas Conservation Act require the Minister of the Environment to assume responsibility for final approval of the environmental aspects of all gas processing operations, including the underground storage of gas. In this way environmental decisions issued by the Board are subject to prior confirmation by the Minister of the Environment.

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PART 5

RECOGNIZED AIR POLLUTANTS, THEIR DISPERSAL AND DETECTION

5.1 Introduction

We have seen that the Energy Resources Conservation Board devises, issues and enforces regulations designed to maintain pollution levels which are set principally by the Department of the Environment - or more stringent standards if the Board so prescribes. The appended Air Quality Standards (Appendix 1) prepared by the Air Pollution Control Section of the Department of the Environment establish the air pollutant limitations as currently applied throughout the province.

The obvious pollutant to begin with is sulfur dioxide, as it is the unavoidable (at present) result of less than 100% elemental sulfur recovery. Furthermore, although hydrogen sulfide is possibly just as obvious, if not more noxious, regulations imply that it should not be admitted to the atmosphere at all. That is, wherever feasible hydrogen sulfide is to be combusted to sulfur dioxide. In so turning our attention to this common pollutant we are led to a consideration of incinerator stack design and subsequent dispersal of the sulfur dioxide issuing from such a stack.

5.2 Stack Design Criteria

In that part of new plant approvals dealing with incinerator stack design and sulfur dioxide emission, such approval is based upon a calculated maximum one-half hour ground level concentration to be expected, given certain simplifying assumptions, from a stack of given height. The sulfur dioxide standards used for stack design purposes are:

(a) 0.20 ppm for a 30 minute averaging period to be used in urban and arable agricultural areas (this implies range land falls into class (b)),

(b) 0.30 ppm for a 30 minute averaging period to be used in all other areas with due allowance made for the height of trees in forested areas, and

(c) 1.0 ppm to be utilized for emergency flaring periods not exceeding one hour in duration.

The sulfur dioxide discussed is formed in an incinerator used for the burning of unrecovered sulfur compounds contained in the tail gas leaving the sulfur recovery plant. This tail gas contains sulfur compounds in the form of hydrogen sulfide, sulfur dioxide, carbonyl sulfide, carbon disulfide, sulfur vapor and droplets of entrained sulfur liquid. To confine emissions to chemicals considered to be least noxious and harmful the tail gas is thus combusted to oxidize all such sulfur components to sulfur dioxide. The additional constitutents of the incinerator gas, as far as they have been analyzed for, are given in Table 3.1, Column 9 for a typical plant.

Since sweet gas (methane) is also added to provide the heating value specified, this analysis should also include the water vapor arising from sweet gas combustion. In this way, the completely combusted tail gases are exhausted to the atmosphere at a temperature of at least 1000°F through a stack of sufficient height to yield a calculated maximum half hour ground level concentration of sulfur dioxide within the prescribed limits for that particular location. Half hour limits are set only to be in harmony with the requirements of the equations used by the Department of the Environment and the industry in establishing acceptable stack heights.

5.3 Meteorology

Pollutants and other plant effluents are carried by the wind and, at the same time, diffuse or intermingle rapidly with neighboring parcels of air. The main causes of this mixing are (1) the eddies and currents occasioned by the shearing motions of the air when it encounters an obstacle such as a building or hill, and (2) vertical exchanges of warm buoyant air (heated by land or water surfaces) with cooler, denser amounts of air that sink down to replace or mix with them. The first effect is the familiar mechanical turbulence which is capable of producing both vertical and horizontal mixing, while the second, known as thermal turbulence, is the major mechanism by which vertical mixing of pollutants takes place. Mechanical turbulence is strongly influenced by the wind speed and terrain roughness, while the prime environmental factor influencing thermal turbulence is the vertical temperature gradient of the atmosphere. When the gradient is such that warmer air overlies cooler air the atomsphere is said to be stable, vertical motion of air particles is hindered, and a temperature inversion is said to exist. When the temperature gradient is reversed, mixing can take place and a situation of instability is said to exist: air mixing or thermal turbulence can take place to alleviate local build-up of high pollutant concentrations. A common situation is one in which an inversion is found 500-600 feet above the surface of the earth, the vertical mixing of pollutants thereby being limited to a thin section of air lying between the ground and the base of the inversion. Local factors that influence the volume of air available for dilution of pollutants include land-sea breezes, mountain valley winds caused by differential heating of the surface, surface roughness, and possible heat radiated from buildings.

Such broad remarks also take cognizance of possible stagnant air masses being pocketed below surrounding hills or similar slow-moving, trapped, air under dense forest cover.

5.4 Air Chemistry of Sulfur-Containing Compounds

5.4.1 Sulfur Dioxide

After sulfur dioxide enters the atmosphere, it is oxidized by one of two pathways to sulfuric acid or a sulfate salt. The first path consists of oxidation to sulfur trioxide (SO_3) with subsequent hydration to form sulfuric acid, which may react further with atmospheric particles to form sulfates. The second path involves uptake of sulfur dioxide by aerosols (an agglomeration of molecules) or dust particles, in or on which sulfur dioxide is catalytically oxidized to sulfate salts. Airborne bentonite soils, such as occur in Alberta, are efficient catalysts in this regard. Oxidation of sulfur dioxide can also occur directly in the hot stack gas in the presence of oxides of nitrogen or metallic oxides. While the direct rate of photochemical oxidation of sulfur dioxide is about 0.1% per hour in unpolluted air, this rate goes up to 10% per hour in noonday sun in the presence of as little as 0.1 ppm of olefinic hydrocarbon plus 0.3 ppm of nitric oxide (NO). In the situations normally encountered in rural Alberta, photochemically induced removal of sulfur dioxide is probably not nearly as important as those mechanisms of heterogeneous catalysis.

In some urban areas, sulfuric acid and sulfates account for 5 - 20% of the total particulate matter in the atmosphere (no data is available for Alberta). These particles come to earth through the action of precipitation (snow, hail, or rain) and by simple coagulation, settling, and absorption at the surface of the earth.

Case studies of convective storms in Central Alberta by the Alberta Hail Studies Group showed that 20 - 60% of the sulfur dioxide entering such storm systems by updrafts through the cloud base is removed by rain droplets and deposited as sulfate in the vicinity of its origin. Even though typical Alberta sulfate concentrations in rain water of 2.0 - 4.0 mg/l are above the world-wide background of 0.5 mg/l, they are still well below the values for industrialized areas of North America. The long term effect of this sulfate accumulation is, however, an increasing matter of concern.

Since convective storms occur in Central Alberta on the average of once every other day, it would appear that in summer most sulfur dioxide is removed before the air leaves the province. This sutiation contrasts radically with that which undoubtedly prevails in the winter. Snow is a very inefficient scavenger of sulfur dioxide, partly because snow is formed as a solid and the low temperatures encountered slow down all physical processes which lead to the incorporation of sulfur dioxide in the snow crystals. In the winter, while 10 - 15% more sulfur dioxide is emitted than during the summer months, its removal mechanisms are appreciably less efficient, and less well understood. Under these conditions the everage lifetime of sulfur dioxide (three to four days) may be such as to finally bring it to earth or to convert it to sulfate at great distances from its source. This subject has received almost no research effort.

5.4.2 Hydrogen Sulfide

Studies have indicated that hydrogen sulfide is rapidly oxidized by the normal ozone background in the atmosphere. This oxidation process is presumed to occur on the particulate matter normally present in the air. Given a reasonable ozone level of 0.05 ppm and an estimate of the particulate concentration in the air, it can be calculated that one-half of any hydrogen sulfide present is oxidized every 5 hours. Many independent confirmations of this half-life have been made. No figures are available on Alberta background hydrogen sulfide levels; on a world-wide basis a value of 0.1 part per billion (0.1 ppb) is estimated.

Other than what has just been mentioned very little is known in detail about the processes which convert hydrogen sulfide to sulfate in the atmosphere. It is a fact that in the laboratory a few tenths of a part per million of nitrogen oxides are capable of photochemically converting hydrogen sulfide to sulfuric acid. Whether this is a reasonable pathway in ambient air is so far speculative.

5.4.3 Other Sulfur Compounds

Like hydrogen sulfide other sulfides such as carbonyl sulfide, carbon disulfide, and mercaptans, also do not absorb energy in the visible spectrum to become activated or dissociated. In the presence of ozone or other photochemically active species, such as nitrogen oxides, they do react in the laboratory to eventually form sulfur dioxide or sulfinic acids, which are themselves the source of eye-irritating aerosols.

While the fundamental chemistry of possible individual atmospheric chemical reactions have been quite well documented in the laboratory, here in Alberta we have only made a beginning into the analysis and fate of the possible constitutents of our atmosphere. In order to give more sophistication to present monitoring information we shall need to know such things as the composition of the particulate matter, concentrations of ammonia, heavy metal oxides, sulfates, and hydrocarbons, all of which have been implicated in health deterioration associated with air contaminants.

5.5 Stack Dispersal to Ground

The ground level distribution of pollutants emitted by a stack varies with the distance from that stack in a complicated way. Generally it would be expected that this concentration would be low near the stack, increase, go through a maximum and then decrease as it recedes from the point of emission. What happens in practice cannot as yet be predicted with any real accuracy. Only generalizations can be made based upon the assumptions inherent in the mathematical formulas used to arrive at an acceptable stack height.

Where the maximum ground level concentration will occur depends in part on the atmospheric stability. During unstable situations (high turbulence), a maximum concentration can be expected near the stack; as atmospheric conditions become more stable, the maximum moves progressively further from the emission point. A general rule of thumb indicates that the maximum ground level concentration occurs 10-20 effective stack heights down wind.

The amount of pollutant recorded at every ground level point is expected to change in the same proportion as the rate at which pollutant is discharged through the stack. Additionally, the formulas used imply that the average down wind concentrations of pollutant vary inversely with the square of the stack height: doubling the stack height will decrease all ground level concentrations to one-fourth of their original value.

The formulas used to establish a proper stack height and pollutant emission rate have a certain amount of physical justification, they are basically just useful approximations. A recent field study in Alberta concludes that the Sutton and Pasquill equations used in stack design normally result in actual ground level sulfur dioxide concentrations that are well within the prescribed allowable limits, but that caution is warranted in cases of extreme topography. Interestingly, this study found little difference between the concentration frequency distribution down wind of the emitting source and data from all other directions. It would, off-hand, be expected that dispersion of pollutant about the plume center-line would fall off quickly.

5.6 Acid Gas Flare

Flaring is normally utilized during plant upset, turn around, or other abnormal plant procedures. It is also used on a continuous basis where the sulfur content of the raw gas delivered to the plant is insufficient to warrant the installation and operation of sulfur recovery facilities, as is the case for twenty-five sour gas plants.

In emergencies resulting in a large release of sour gas to flare, gas plant approvals require the plant operator to burn sufficient sweet gas with the sour gas flared to ensure complete combustion and to provide sufficient thermal uplift to the flared gases to prevent ground level sulfur dioxide concentration from exceeding the limits decreed. Whereas incinerator stacks may be 200 - 500 feet high and 15 feet in diameter, flare stacks are of lesser height and diameter. The empirical calculations employed in flare stack design are very suspect in the author's opinion and should perhaps be the subject of additional research to justify their adaquacy. In the case of incinerator stacks, combustion takes place at the base of the stack and the temperature gradient up the stack must be such that the gases exit at greater than 1000°F. Gases vented to flare stacks, in contrast, are ignited by a pilot light at the flare stack mouth.

While practice dictates that gases to flare must have a heat content of at least 250 B.T.U. per cubic foot, and while in addition, an average flame temperature of 1800°F is assumed, no actual tests of the completeness of combustion have been conducted. In extreme cases of plant upset, it is possible to produce flare stack flames 100-200 feet in height which may be visible for 30-40 miles. For flames of this size and velocity, it is conceivable that due to possible incomplete combustion, at least around the perimeter of the flame, a variety of oxgenated hydrocarbons are passed into the surrounding air. Though, as mentioned earlier, their existance and concentration have not been dealt with, the types of compounds suggested would seem to duplicate those normally implicated in the irritating effects of urban smog.

It is also interesting to observe in this connection that in the Pincher Creek area the Department of the Environment conducted gas-chromatographic analyses of ambient air in the hopes of detecting possible odorous hydrocarbons. Partially oxygenated species such as aldehydes and ketones were not mentioned in this survey, yet they would be logical contenders as possible sources of noxious odors even at very low levels.

5.7 Incinerator Stack Monitors

There is no question that local topography and meteorological conditions can lead to contaminant levels at variance with gross predictions. It is also quite possible under proper atmospheric conditions and high wind speeds for plants to grossly exceed their allowed stack sulfur dioxide concentration without this violation being detected by ground level monitors. Each plant is therefore now required by the Energy Resources Conservation Board to report monthly a complete sulfur balance around their operation to ensure that their prescribed recovery efficiency is maintained regardless of raw gas input rate. This has eliminated the above possibility. In addition, plants are required to have installed some form of continuous stack pollutant monitoring device. These are usually infra-red or ultra-violet photometric sulfur dioxide detectors, though gas-chromatographic systems are also in use. Such instruments, in principal, are capable of instant read-out with a telemetering capability to perform master-slave routines with the front end of the sulfur plant. In fact, de-bugging of this new equipment in many instances is still proceeding, which means that sulfur balances are often made by subtracting from the plant inlet sulfur the amount of sulfur gauged in the pit and calling the difference sulfur incincerated to sulfur dioxide through the plant stack. The accuracy of this method has been questioned in a previous section dealing with calculation of sulfur plant efficiency, therefore considerable effort is being devoted to adapting the monitoring equipment to plant conditions.

5.8 Off-Site Ground Level Monitoring

5.8.1 Exposure Cylinders

Today the usual survey method for sulfur dioxide and hydrogen sulfide is by means of so-called "exposure cylinders". This entails exposing strips of lead dioxide (for total sulfation) and zinc acetate (for hydrogen sulfide) to the atmosphere for a known period of time. Neither reagent is capable of detecting organic sulfur compounds (e.g. mercaptans, carbonyl sulfide, carbon disulfide). It is common practice to use these exposure cylinders to obtain background ambient levels before a sour gas plant goes on stream in addition to their habitual use once the plant begins operation. The cylinders are usually exposed for one month with the pollution figures submitted to the Department of the Environment by the end of the succeeding month, who then relay the information, citing any irregularities, to the Energy Resources Conservation Board.

The number and distribution of such exposure cylinders are determined between the plant and the Department of the Environment. These are then usually serviced either by the plant or a private concern hired by the plant operator. Each of such monitoring stations is considered on its own since each has its own unique micro-topography and meteorological conditions. Thus, it is difficult to compare data from the various exposure cylinder monitoring sites, except as individual sites on a yearly basis. Furthermore, this type of equipment gives only monthly averages and cannot give information about possible occurrences of high local pollutant levels: these are smoothed out over the month. More serious is the fact that exposure cylinder data is presented in a form completely unrelated to the units in which current ambient air quality standards are given (parts per million and micrograms per cubic meter). The ability of exposure cylinders to function properly at our extreme winter temperatures has yet to be determined. It is precisely this season of the year when plants are operating at or nearest to their capacity and would be emitting a maximum amount of pollutants.

5.8.2 Mobile Air Monitoring Trailers

In point of fact, the heart of the monitoring system is considered by air monitoring personnel to be the mobile air monitoring trailers, as these contain the apparatus capable of providing minute-by-minute air quality information in a form which can be translated into the defined ground level limits for hydrogen sulfide and sulfur dioxide. Unfortunately, such trailers are of limited mobility and require a readily accessible source of power. Furthermore, it is only following prior independent definition of a particular site as one of high pollutant concentration that the trailer facility might establish the time dependence of contaminant concentration. Time delays and changing climatic conditions would seem to mitigate the practicality of such units except as where a number of such units were in service simultaneously. The Department of the Environment has two such monitoring trailers, and will have two more by fall, with which to police the entire province. New directives suggest that by 1973, plants of over a prescribed size in sulfur production will be required to possess at least one mobile unit of their own. Since most large sour gas plants already operate such trailers, this order simply formalizes existing circumstances. The cost of a completely equipped trailer runs to $20,000.00. Such equipment includes automatic hydrogen sulfide and sulfur dioxide monitoring instrumentation, wind speed and direction gauges and possible telemetering facilities connected to the interested plant. Whether such trailers operate as efficiently in winter as summer would be worthy of comment.

5.8.3 Sulfur Dust Fall Monitors

As a result of the concern over incidents of soil sterility and reduced crop yields attributed to wind blown sulfur dust, sulfur producing plants are additionally required to maintain sulfur dust fall monitors. The data obtained from these are reported on the same 30 day basis as the exposure cylinders. Since the majority of plants do not ship any more block sulfur (slated sulfur alone is accepted at Vancouver), the specification of these units is somewhat redundant, as the dust problem is of real concern only during breaking and loading of the blocks. However, the problem may arise again because plant operators will have to consider re-melting and slating of the existing blocked sulfur as a possible means of reducing existing stockpiles.

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PART 6

OTHER SOURCES OF POSSIBLE ENVIRONMENTAL CONTAMINANTS

Without bringing into consideration the monumental question of alleged off-site accidents and intermittant plant upsets, there exists a number of waste chemical disposal problems within the normal routine of the plant which deserve mention.

6.1 Process Waste Water and Liquid Chemicals

The Department of the Environment normally maintains jurisdiction over this aspect of plant operation.

Process waste water is often retained and may be treated in large open ponds before being disposed of to a surface body of water, or, if the amount of water is small, before it is allowed to evaporate to the atmosphere. The ponds may also be a source of air pollution due to "weathering" of the wastes contained in them. Substances discharged to such ponds may be any one or all of the following types:

1. Cooling water treating chemicals (phosphates, chromates, chlorine, biocides, sulfuric acid, corrosion inhibitors, etc.).
2. Boiler water treating chemicals (lime, chelates, phosphates, corrosion inhibotors).
3. Sour Water. In those cases where this is not re-injected down a well, it is usually stripped of its hydrogen sulfide before removal to settling ponds.
4. Oils and greases. These normally arise from machinery such as compressors and pumps. Recent plants have completely enclosed drainage systems to prevent such water immiscible substances from entering the ponds.
5. Spent treating chemicals. These would consist of spent caustic or amine carry-over, possibly saturated with hydrogen sulfide. In some cases these chemicals can be incinerated to dispose of hydrogen sulfide.
6. Products of Corrosion. Iron sulfide and sludges are produced or carried through the amine sweetening step and are removed in an amine clean-up procedure, the residue from which usually goes to the settling pond.

The magnitude of the problem caused by the disposal of these wastes depends very much upon the efficiency of individual plant operation, the size of the processing operation and the composition of the inlet gas to the plant. Orders of magnitude can be suggested for some types of waste. One plant estimates it must replace four pounds of amine per million cubic feet of gas processed. For a plant operating on 45 million cubic feet per day, this would imply the need to replace 180 pounds of amine per day. Naturally not all of this represents degradation products or sludge; most of it is carry-over to the Claus units. The amine clean-up units consume around 21 pounds of diatomaceous earth per day in performing their sludge and iron sulfide removing job. This residue normally goes to the settling pond. As another example, a particular plant of 100 million cubic feet per day inlet capacity admits an estimated 3 gallons/minute of waste water and treating chemicals to their settling pond. Another operator periodically dredges the sludge from the bottom of his pond and uses this material to improve dikes around the pond.

Aeration can be employed to oxidize chemicals in the waste water which would otherwise rob oxygen from aquatic life.

6.2 Other Materials Used

Spent bauxite catalyst, molecular sieve and solid drying agents also often require disposal. These waste chemicals do not normally create a source of off-site pollution and can be buried in pits or used as land fill on the plant site. The amounts of catalyst involved again varies. During plant turn around, plants must dispose of or regenerate from 50 to over 200 tons of catalyst. Such turn arounds normally are on a 1-2 year cycle, although shorter periods are not unusual and again depend upon the intricacies of plant operation. Bauxite is an aluminum oxide with a few percent of iron oxide. The inactive spent form contains appreciable water soluble aluminum sulfate. The environmental effects resulting from leaching of this material are unknown. It is not unusual to see spent catalyst spread around the plant site or used as road gravel.

6.3 Vapours, Storage Tanks

Stored pentanes plus can cause pollution by the evaporation and release to the atmosphere of the lighter hydrocarbons and sulfur gases (primarily hydrogen sulfide) in the product. Gas plant approvals require that the product be stored at a vapour pressure less than atmospheric to minimize evaporation loss. In addition, stock tank vapour recovery facilities or stock tank vapour flares are often used but are not mandatory.

6.4 Burn Pits

Disposal of water and hydrocarbons (often containing dissolved hydrogen sulfide and mercaptans) to burn pits can result in a pollution problem. Odors may result from the "weathering" of liquids in the pit and smoke and sulfur dioxide can result if a significant amount of burning takes place.

Normally a continuously burning pilot flame is placed over the point where the wastes flow into the pit to burn any combustible gases evolved. Sulfur dioxide, carbon dioxide and water vapour are the products of this combustion. This is true if combustion is complete. However, the appearance of smoke is a good indicator that combustion is not complete. Under these conditions noxious aldehydes, ketones, mercaptans and similar species can be formed through partial oxidation and thus contribute to air contamination. Sufficient fuel should always be added to ensure combustion is indeed complete. The same reservations (as mentioned for flare stacks) hold for the operation of these burn pit flames.

The quantity of wastes disposed of to the burn pit should be minimized. Closed drain systems are now piped into a liquid hydrocarbon recovery tank rather than flowing to the pit. The liquids from this tank can be pumped back into the plant and the vapours can either be recovered or vented to flare. Liquids entering open drain systems are not as easily recovered. For this reason hydrocarbon liquids and sour liquids should not be allowed to enter the open drain system.

In the field, when a new well is ready to go on stream, it is necessary to first clear from the well all the materials used in the drilling operation.

These can include carbon monoxide, drilling mud, sulfuric acid, hydrochloric acid, hydrogen sulfide, salt water and of course the hydrocarbon in the well. All of this is blown to a 'knock-out pit' provided with flaring facilities. Since the composition of the effluent going to the knock-out pit is not accurately known there is no assurance that it will burn. If it doesn't and the well is an acid gas well some noxious chemicals may be vented in large quantities to the environment.

6.5 Liquid Sulfur Storage Pit Vapours

Hydrogen sulfide dissolved in the liquid sulfur product can be released from such liquid sulfur when in the liquid sulfur storage pits. This gas is normally vented to the atmosphere through a stack on the pit roof. The quantity is normally small and does not usually create a pollution problem although an odor may sometimes be obvious in the vicinity. Where sulfur is transported in tank cars as a liquid, by the time the material arrives at its destination sufficient hydrogen sulfide may have degassed or be degassed during the re-heating of the tank cars to be of serious concern to those persons employed in the unloading operation. In fact fatalities are known to have occurred through lack of precaution.

6.6 Monitoring and the Local Resident

A fair comment would be that the complaints of local residents, coupled with the usual ready compliance on the part of plant operators in reporting incidences of excessive emissions, are the real heart of the present detection system, since this to a large degree initiates detailed investigation by the Board or the Department of the Environment; and such complaints assist in determining the location of the mobile monitoring equipment.

REFERENCES

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PART 7

PROPOSED FUTURE ANTI-POLLUTION GUIDELINES AND MONITORING DIRECTIVES

7.1 Anti-Pollution Guidelines

As early as July, 1970 the Energy Resources Conservation Board, in meetings with operators of gas processing plants and through the issuance of recent processing plant approvals, indicated that an increase in sulfur recovery efficiency would be required consistent with current trends in technology and the provincial Ambient Air Quality Standards of September, 1970 (refer to Appendix I). Indeed, with the advent of 2000-4000 LTD sulfur recovery plants, the present maximum of 96% recovery still means 80-160 tons per day of sulfur emitted as sulfur dioxide with no hope of profitable recovery in the future. Accordingly the Energy Resources Conservation Board set out the guidelines given in Table 7.1 For a 2000 ton per day plant this nevertheless permits a loss of 20-40 tons per day of sulfur.

TABLE 7.1

ALBERTA'S MINIMUM SULFUR RECOVERY EFFICIENCY GUIDELINES, ENERGY RESOURCES CONSERVATION BOARD. (REFERENCE 1).

Sulfur in sour gas, Inlet rate long tons/day	Process requirements	Required recovery efficiency (%) for various acid gas qualities		
		Favorable	Average	Unfavorable
1,000 to 4,000	Stack cleanup required	98-99	98-99	97-99
400 to 1,000	Minimal Stack cleanup or equivalent process	96-98	95-98	94-97
100 to 400	Minimum of 3-stage Claus plant or equivalent process	94-96	93-95	92-94
10 to 100	Minimum of 2-stage Claus plant or equivalent process	93-94	92-93	90-92

It would appear at present that these tighter restrictions on sulfur emissions will compel modifications to at least twenty-one of Alberta's sulfur recovery plants. Existing plants will have to meet the new criteria by no later than December 31, 1974. Applications for exemptions from sulfur recovery guidelines if such were to be made, were required by May 31, 1972. Applications for proposed plant modifications must be made before May 31, 1973. While these sulfur recovery rules are strict, they are not as stringent as those of the Texas Air Control Board because Alberta guidelines allow more adjustment for plant size The Alberta regulations as published do not spell out directly what is implied by Favourable, Average and Unfavourable acid gas qualities. However, operators of affected plants have been advised by the Board by letter, of the category the Board considers the plant to be in.

A comparison of sulfur dioxide air quality objectives of Alberta, Ontario, Canada, and the United States, Table 7.2, shows close agreement among the objectives of Alberta, Ontario and Canada. Further comparisons can be made on the basis of the following information as well. Japan specifies an annual average of under .05 parts per million to be attained in developed areas within ten years. The tolerance is presently set at 0.12 parts per million as the annual average. In Germany the 24 hour average is 0.15 parts per million with the half-hour maximum at 0.29 parts per million. Rumania tolerates a 24 hour average of 0.04 parts per million with peak values of 0.14 parts per million accepted.

TABLE 7.2

SULFUR DIOXIDE AIR QUALITY OBJECTIVES AND STANDARDS, AVERAGE VALUES IN VOLUME UNITS (PPM) NOVEMBER 1971 (REFERENCE 3)

PERIOD OF EXPOSURE	ALBERTA (Standards)	ONTARIO (Objectives)	CANADA (Maximum Acceptable objectives)	UNITED STATES (Secondary Standards)
1 hour	0.30	0.25	0.34	0.50*
24 hours	0.10	0.10	0.11	0.10
1 year	----	0.02	0.02	0.02

*Three-hour maximum

7.2 Monitoring Directives

7.2.1 Continuous Measurement of Incinerator Stack Emissions

Plants recovering more than 100 LTD of sulfur, or those emitting to the atmosphere more than 10 LTD of sulfur, are requested to provide a continuous record to the Energy Resources Conservation Board of the daily quantities of sulfur dioxide and other sulfur compounds present in the stack gases. A deadline of September, 1971 may, by individual application, be extended to September, 1972 in order to give operators time to familiarize themselves with the continuous monitoring equipment (gas-chromatography or infra-red techniques). To date, the plants affected by this directive have had varied success in adapting the available technology to their individual needs. Although the Information Letter released to plant managers indicates that sulfur compounds other than sulfur dioxide are to be looked for in stack gases, it would appear that this aspect is not of critical importance at present; only sulfur dioxide is monitored.

7.2.2 Pollution Control Division, Department of the Environment

As mentioned above, the Department of the Environment looks after off-site monitoring. In this case a single report is submitted by the plant on a monthly basis, containing the following:

(a) Exposure cylinder data.

(b) Explanation for any high cylinder levels.

(c) Map of plant area.

(d) Sulfur dust fall cylinder data (where applicable).

(e) Continuous hydrogen sulfide and sulfur dioxide monitoring data (where applicable).

(f) Explanation for any high hydrogen sulfide and/or sulfur dioxide readings.

(g) Plant operating data. Frequency of wind speed and its direction. Instrumentation operations data.

These items have always been part of past and present operating procedure except for the requirement of sulfur dustfall analyses. In response to the increasing size of the industry and its increased environmental impact, Regional Offices have been opened in Calgary, Red Deer and Whitecourt which are part of the community health program. The staff (one technician and one trailer) of these offices are responsible for the collection of local water samples where their acceptability for consumption has been questioned.

In accord with Energy Resources Conservation Board directives asking for continuous stack monitoring for plants having maximum emission approvals of greater than 10 LTD of sulfur in 1972, the Pollution Control Division has specified that such plants also conduct a continuous off-site survey of sulfur dioxide, hydrogen sulfide, wind direction and velocity. The survey is for a minimum period of one month and should cover the interval around the annual plant turn around (catalyst regeneration). As of January 1, 1973, all plants, except those where a continuous year-round hydrogen sulfide and sulfur dioxide monitoring directive applies, must undertake a continuous type of survey as outlined above. This will require all plants affected to have at least one mobile monitoring trailer as described earlier. Even now some plants have had cause to employ as many as seven mobile monitors simultaneously.

The results of the continuous monitoring of hydrogen sulfide and sulfur dioxide can be telemetered easily and instantaneously to the plant or operate an alarm in the plant control room. The possibility of an alarm system triggered to sound when the sulfur dioxide and hydrogen sulfide concentrations at the mobile station is, say, 50% or 75% of the air quality standard, would allow the plant to instigate corrective procedures before a potentially dangerous situation develops.

An additional very necessary service is also to go into effect. In order to assure uniform laboratory procedures a common reference lab will be set up in Edmonton. Individual labs analyzing hydrogen sulfide and total sulfation cylinders will be requested to send one of each kind of exposure cylinder to this Edmonton clearing house for confirmation. A similar service is also contemplated to regularly standardize continous monitoring equipment.

With the advent of sophisticated laser technology and sensitive infra-red radiation detectors, it is now quite feasible to obtain information on the chemical composition of smoke plumes and the health of vegetation by airborne remote sensing instrumentation. Such equipment has in fact been offered by the Federal Government to the Alberta Department of the Environment at a minimal charge. No decision has been reached in this matter as yet.

Water analyses now routinely include testing for a number of potentially harmful trace metals, among these are mercury, selenium, cadmium and lead. Unfortunately the present staff of the Water Pollution Branch of the Department of the Environment consists of one engineer and four technicians. It is hoped to increase this to three engineers, two biologists and eight technicians within the year.

7.3 Pollution Inventory

Early in 1972 the Energy Resources Conservation Board was requested by the Minister of the Environment to initiate a pollution control and occurrence survey into the various phases of the energy resource industries which are specifically administered by the Energy Resources Conservation Board. This inventory is to include the statistics up to June 30, 1972. Such an accounting will include those aspects of pollution occurence and control listed below. (Inquiries as to the date of availability should be directed to the Board).

1. A statistical indication of the size of the industry, to be used in future inventories to make suitable allowances for growth in the base.
2. The sources and types of pollutants.
3. Measurements of pollutants and their effect on the environment or the community.
4. A review of the current pollution control requirements and standards.
5. A statistical indication of the degree of enforcement, e.g. frequency of inspections, results of the inspections, comments regarding methods of enforcement.
6. A review of the unsolved pollution problems and the steps being taken to solve them.
7. A summary of the general condition of this phase of the industry.

The type of information to be derived from the survey in the areas of interest to this report are detailed as follows:

A. Producing Wells and Batteries

1. Basic Statistics: Number of wells and batteries, oil production rate, sour gas production rate, average and range of hydrogen sulfide percentages, salt water production rate.

2. Pollution Sources: sour gas emissions, oil and salt water spills, smoke, odours, noise, weeds, excavations, etc.

3. Effects Noted or Reported: Paint discoloration, rust, vegetation damage, water taste, visual, analysis, odours, ambient air analysis, exposure cylinder data, verified complaints.

4. Current Control Requirements: tubing, casing, cement, safety valve, fences, signs, stacks, vapor gathering, spill reporting and clean-up, lease maintenance, salt water disposal, pit limitations, production equipment specification.

5. Enforcement: frequency of inspection, total numbers, results coded as to unsatisfactory conditions, action taken to enforce regulations.

6. Unsolved Problems: maintenance of leak-tight equipment in sour and corrosive atmosphere, achievement of tight systems for sour gas, salt water, and oil, odour identification.

7. General Condition of Wells, Batteries and Leases.

B. Drilling Operations

1. Basic Statistics: number of wells drilled per year, general comment on active areas.

2. Pollution Sources: blowouts, mud spills, drill stem test oil, sour gas, engine oil, rig wastes, engine noise, drill stem test noise, mud disposal.

3. Effects Noted or Reported: noise, odour, vegetation damage, stream pollution.

4. Current Control Requirements: over water and near water drilling, sump location and construction, blowout prevention equipment and practices, casing and cementing, Department of Lands and Forests requirements, site clean-up, mud disposal, well abandonment programs.

5. Enforcement: frequency of inspections, total number, results coded as to unsatisfactory conditions, action taken, (inspections by other agencies, e.g. Lands and Forests).

6. Unsolved Problems: mud disposal, lake shore and stream bank protection, park and wilderness areas compatibility.

7. General Condition of Drilling Operations.

C. Gas Processing Plants

1. Basic Statistics: number of plants, number of plants processing sour gas, plant throughput and production of various products, total hydrogen sulfide inlet to plants, range in hydrogen sulfide content of inlet gas, per cent of inlet gas flared, total sulfur emitted to the atmosphere.

2. Pollution Sources: flaring of hydrocarbons, venting of hydrocarbons to atmosphere, regular sulfur dioxide emissions, emergency flaring of sour gas, emergency emissions of sour gas, sulfur dust, burn pit, liquid sulfur vapours, liquid sulfur pouring or loading, produced water, process water, smoke, odours, noise, metals in flared hydrocarbons, spent chemicals, sour water stripper vapours, glycol regenerator vapours, other plant waste.

3. Measurement of Pollutants and Effects Noted: measurement of emissions, offsite monitoring and exposure cylinder results, complaints of respiratory ailments, dizziness or black-outs, headaches, odours, noise, livestock illness, damage to crops, rust, paint discoloration.

4. Current Requirements: Regulation requirements including approvals prior to construction, requirements for hearing or notice, ground level standards, measurement of stack emissions, burning hydrogen sulfide to sulfur dioxide, filing of emergency procedures sulfur balance reports, smoke control requirements; requirements specified in approvals

including maximum raw gas inlet rate, maximum hydrogen sulfide inlet rate, conservation standards, maximum sulfur dioxide emission rate, minimum incinerator or flare stack heights, minimum stack emission temperatures, restrictions to flaring, continuous burning pilot, addition of make-up fuel gas, minimum number of stack surveys, minimum net work of pollutant detection equipment, pentanes plus vapour pressure requirement, sulfur dust control, adequate storage and loading facilities.

5. Enforcement: frequency of plant inspections, results of inspections, action taken, frequency of stack surveys, amount of Government monitoring, action taken related to surveys and monitoring, review of production reports for recoveries, review of sulfur balance report, results of report reviews, action taken.

6. Unsolved Problems: higher sulfur recovery efficiencies, stack emission measurement, relation of stack emissions to ground level concentrations, sulfur dust, ground level emissions of pollutants, smoke control.

7. General Condition in Gas Processing Plants in the Province.

D. Oil and Gas Pipe Lines

1. Basic Statistics: miles of various sizes and types of pipe line, throughputs of various types of fluids (map to show locations).

2. Pollution Sources: oil or sour gas from leaks and breaks, surface disturbance, salt water spills.

3. Effects Noted: vegetation damage, temporary air or water pollution, reduced soil productivity.

4. Current Control Requirements: design, construction, spill clean-up, safety valves, signs.

5. Enforcement: inspection frequency, total inspections, action normally taken to enforce requirements, testing.

6. Unsolved Problems: leak detection, corrosion forecasting, spill containment, river crossings, muskeg oil spill clean-up.

7. General Condition of Pipe Line Construction and Operation.

E. Pipe Line Terminals, Storage and Compressor Stations

1. Statistics: number, storage capacities, throughput, location (map), horsepower installed.
2. Sources & Types of Pollutants: hydrocarbon vapours, station wastes, engine exhausts, noise, blow down or bleed-off points.
3. Effects Measured or Reported: complaints, ambient air analyses, vegetation damage.
4. Control Requirements: ground level concentration standards, noise levels, housekeeping, waste water standards, vapour conservation.
5. Enforcement: virtually nil, (inspections planned before June).
6. Unsolved Problems: to come out of inspections.
7. General Conditions.

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PART 8

TAIL GAS CLEAN-UP

Any discussion of the possible justification for the turn to stricter ambient air quality standards not only in Alberta but throughout the northern hemisphere has been studiously avoided in this presentation. There is no question that the energy consumption of industrialized countries is expanding at a phenomenal rate and is expected to do so into the predictable future. Indeed if pollution limits were not made stricter now, then future generations would not benefit from those facets of our rising technological capabilities, which would seem to suggest that industrial adherence to more exacting emission standards are distinctly possible now.

8.1 Cost

The new sulfur recovery guidelines set forth by the Energy Resources Conservation Board and presented in Table 7.1 do not relate to off-site ground level standards; only to the degree of sulfur recovery and the emission of unrecovered sulfur from the incinerator stack. One can see some possible legal basis for controlling emission at the stack mouth when it is realized that at this point pollutants leave the plant site. Additionally, experience shows that transgression of off-site ground level standards are almost impossible to prove with respect to cause and effect.

The new guidelines on sulfur recovery efficiency will require that of the forty or so sulfur recovery plants twenty-one will require varying degrees of upgrading in their recovery facilities. This will involve expenditures up to $5 million for some individual plants, with total cost to the industry of upward of $34 million: What is involved?

Referring to the guidelines in Table 7.1, plants falling in the bottom two categories (perhaps twelve plants) will probably require installation of an additional Claus catalytic converter stage. It is estimated that this will cost $150,000 for a 100 LTD plant and about $250,000 for a 300 LTD sulfur plant. The large extraction plants in the top two categories will have to stand the bulk of the costs, for these plants will undoubtedly be forced to consider some form of Claus unit tail gas clean-up facility. This route will be less costly in the long run than adding additional Claus units which are just incapable of providing the recovery efficiency to be imposed upon the thousands of tons per day plants. For plants hoping to go from 96% to 98% sulfur recovery the cost for a tail gas clean-up facility could be close to \$1.6 million in a 1,000 LTD plant. To achieve 99% recovery will cost the same plant in the vicinity of \$2.6 million.

Figures 8.1 and 8.2 (reference 6) summarize various estimated costs of providing operating facilities for the removal of residual sulfur from conventional Claus units. These costs are high. Estimates derived from these graphs correlate well with other independent sources.

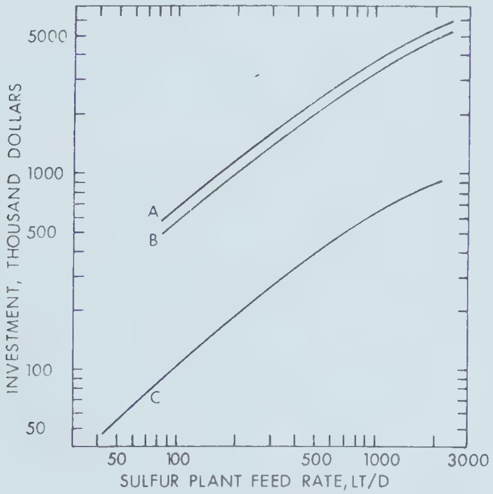

FIGURE 8.1 - INVESTMENT FOR RECOVERY FACILITIES BEGINNING WITH A CLAUS PLANT OF 95% SULFUR RECOVERY:

A. Recovery increased to 99.9%

B. Recovery increased to 99%

C. Add another Claus converter to increase recovery to 96%

(Reference 6)

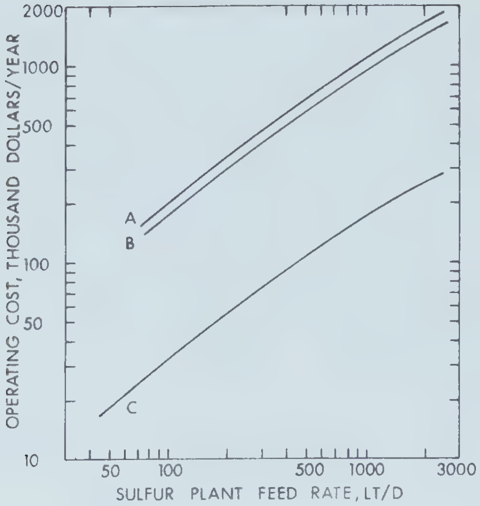

FIGURE 8.2 - OPERATING COSTS FOR RECOVERY FACILITIES BEGINNING WITH A CLAUS PLANT OF 95% SULFUR RECOVERY. A, B, C AS FOR FIGURE 8.1. (Reference 6)

While present recovery limits and their related sulfur emission levels may seem stringent to the industry, this is really an economic limitation and one we, as consumers of energy, must face on somewhat the same grounds. World-wide it is estimated that sour gas processing operations emit 3,000 - 6,000 tons of sulfur dioxide per day. Presently available technology is capable of reducing this to 10-20 tons per day if consumers of gas are willing to pay the costs (reference 7). The economics are such that the costs of environmental protection will not be borne by the additional product recovered, especially at the already depressed price of sulfur. Thus, the current 96% sulfur recovery efficiency has been, relatively speaking, easy. But to carry this from 96% to the 99% presently expected, then to the imperative 99.9% if future prognostications are reliable, will be a real test of the price we are prepared to pay to ensure at least a status quo in environmental quality.

Gas fields don't last forever. Several operators interviewed estimate about 15-20 years as the life of their operating fields. As no new sour gas fields have been discovered in the past three years, and therefore no new gigantic plants are in the offing, the introduction of radically new processes in sulfur recovery is unlikely. Rather, add-on Claus unit clean-up facilities will likely be the short-run answer to more stringent pollution legislation in this province.

8.2 Tail Gas Clean-up Methods

It is to be stressed that the conventional Claus process used in Alberta is capable of bringing stack sulfur dioxide concentrations down to only 5,000 - 20,000 ppm even under the best of conditions. This is going to be 10-100 times higher than acceptable levels. Added Claus units cannot raise conversions to the 99.9% needed to comply with future trends. One solution often proposed hinges on pumping the tail gas into empty wells. This would eliminate the entire problem. After sulfur removal the tail gas is at approximately atmospheric pressure. The size of compressor facility required to bring the gas up to proper pressure for reinjection is said to be economically and auditorily not as reasonable as a first thought might indicate, although helium is currently stored underground in the same way as proposed here for hydrogen sulfide.

In a consideration of possible tail gas treatment schemes one must be aware of the low concentration of hydrogen sulfide and sulfur dioxide which require treatment to yield the desired stack concentrations of sulfur dioxide. For example, acid gas of 85% hydrogen sulfide entering the sulfur recovery facility will be reduced to 1-2% sulfur dioxide (10,000 - 20,000 ppm) in the incinerator stack (See figure 8.3). This is the consequence of reactions producing elemental sulfur, the use of air in combustion rather than pure oxygen, and the volumes of water vapor and carbon dioxide produced in the various combustion processes.

Although a tremendous amount of technical literature exists covering some fifty-odd feasible methods of recovering sulfur present at low concentration, the most succinct and lucid review of the problem and its available solutions has been brought forward by Dr. J. B. Hyne of the Alberta Sulfur Research Institute.

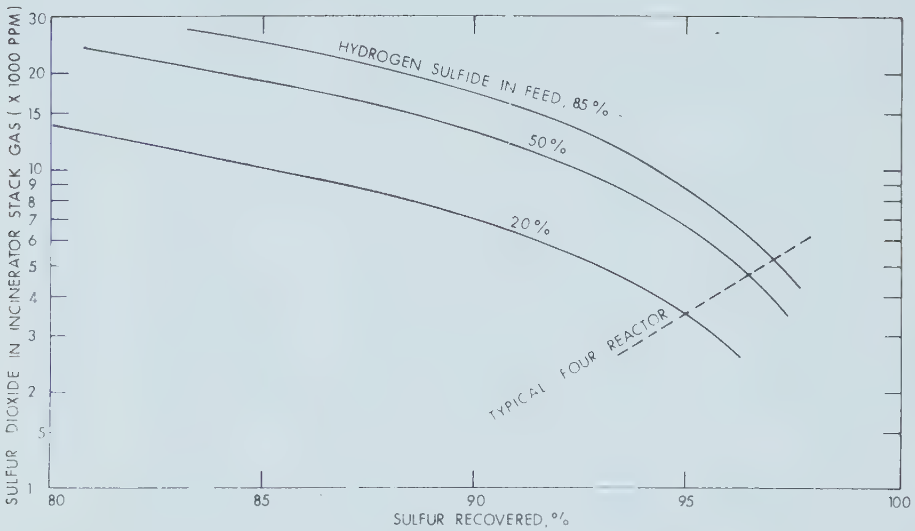

FIGURE 8.3 - SULFUR DIOXIDE IN INCINERATOR STACK GAS VERSUS PERCENT OF SULFUR RECOVERED (Reference 6).

Of the fifty or so processes so far suggested about twenty may be considered seriously for local application. The majority of these twenty involve a reaction between sulfur dioxide and hydrogen sulfide in either a liquid medium in the presence of catalyst or the same reaction occuring principally in the gas phase (Reference 2). The Ram River Aquitaine Plant presently utilizes one of these processes, the so-called Sulfreen process, which makes use of the high catalytic activity of active carbon or alumina, to bring about the hydrogen sulfide - sulfur dioxide reaction needed to recover additional sulfur. Another recent installation in an Alberta plant at Nevis operates upon the same hydrogen sulfide - sulfur dioxide reaction, but in a glycol solvent with the presence of a catalyst (IFP process). Each of these is purportedly capable of sulfur removal to 1000 ppm. In practice, about 4000 ppm is about the lowest level attained by the IFP process at Nevis.

Another process for tail gas clean-up has been announced recently (reference 8) by the Alberta Sulphur Research Limited, an industry-supported sulfur research group at the University of Calgary chemistry department. This method, presently developed only at the laboratory level, uses dimethyl sulfoxide to convert the hydrogen sulfide and sulfur dioxide to sulfur. It has the advantage of also being able to convert carbonyl sulfide and carbon disulfide to sulfur. The use of this new process by the industry will now await further testing at the pilot plant stage.

8.3 Limitations to Clean-Up Procedures

None of the currently feasible procedures is capable of converting carbonyl sulfide and carbon disulfide (600 - 1000 ppm in the tail gas) to recoverable sulfur. If and when stack mouth sulfur levels approach 100 ppm the removal of these contaminants will be critical.

These sulfur recovery techniques are not a complete remedy. Each case will have its own kind of waste product, spent chemicals and disposal problems, not to mention the question of waste water disposal resulting from either the heating or cooling of Claus tail gas to make it compatible with the temperature requirement of the clean-up technique. In addition many of these add-ons require close control of the various process variables to match the more sophisticated chemistry involved.

It is apparent that the choice among more than twenty feasible clean-up additions will set a hard economic exercise for the individual plants. The following factors will have to be considered.

a) A process suitable for a 300 LTD plant may not be so for a 50 LTD plant.

b) The efficiency of a clean-up procedure is intimately linked with that of upstream units.

c) Cost sensitivity of the various processes to the feed composition must be considered.

d) Product (most often sulfur) and waste disposal including thermal pollution is a balancing factor.

Returning once more to the Alberta scene, companies here feel they should have more time to evaluate the clean-up processes used at Ram River and Nevis before being forced into a premature decision on equipment. They point to the fact that the knowledge gained in the operation of the Sulfreen unit at Stage I of the Ram River operation has led to reduced costs in Stage II construction. The IFP process has alsc been troubled with by-product waste disposal problems which lower its esteem.

Faced with the Energy Resources Conservation Board sulfur recovery guidelines a plant may feel that it has reached a sufficient stage of obsolesence that it would be uneconomic to continue operation if a substantial new expenditure is involved. It may be possible for some plants presently considered deficient in regard to the guidelines pertaining to their particular plant capacity to cut back production, thus dropping themselves to a lower category. This may allow them to continue operating without any major expenditures for capital equipment.

While the envisaged outlay of $34 million for capital equipment is high, the Municipal Taxation Act may provide a possible tax exemption for such equipment used for general pollution control and abatement (reference 5). It has been recommended that these exemptions from taxation include the following:

A. Batteries

1) Flare stacks and incinerator devices for smokeless burning.

2) Formation water disposal systems. Tanks for waste material disposal.

B. Gas Plant

1) All facilities used to remove carbon dioxide and hydrogen sulfide from the inlet stream, waste amine and disposal systems.

2) Salt water handling and treating facilities.

3) Sulfur recover plant incinerator stack and monitoring equipment and any equipment for incremental sulfur recovery beyond that for economic operation.

It may be pointed out that federal incentives for pollution control and/or abatement also exist under the Department of Regional Economic Expansion and the Central Mortgage and Housing Corporation. In some situations a more rapid rate of capital depreciation is allowed on pollution abatement equipment. What concessions are made in this area are strongly dependent upon the particular objective(s) to be encouraged.

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PART 9

AIR QUALITY AND HUMAN HEALTH

9.1 General Remarks

In this section it is not proposed to directly provide a rationale for the current Alberta air quality standards. Nor is it possible to exhaustively examine the monumental literature on toxic industrial materials. Rather, it is hoped to make some generalizations about the most obvious pollutants associated with sour gas processing plants and to develop some sort of overview to the common concern for what may be thought of as the crux of the gas plant problem.

The basis of present primary environmental quality standards is the direct effect of pollutants on human, animal and green plant vitality. That is, health effects are represented in these standards only to the extent that a particular chemical can be shown to be harmful to human health. A margin of safety is then added. It is not likely, however, that constantly changing human bodies can respond to changes in their environment in such simple fashion. Such a concept cannot take into account the varied effects on people of different combinations of hazardous substances, the synergistic effect (whereby a combination of hazards produces an effect greater than their individual sum) and the effect of changing weather conditions as they influence the behaviour of a potential pollutant. Nor do these standards take account of the reinforcement attendant upon a pollutant reaching a person from various pathways. Fluorides and lead are examples of substances which can be transmitted through the air and other environmental pathways (e.g. water) as well. More attention is also given to the short-term high exposures to a harmful substance than to its continuous low-level effect. Granted, the latter are most difficult to document, especially in our highly mobile society.

The degree of sophistication required of the monitoring potentialities represented by the above point of view is far beyond our present capabilities. However, while crude surveys of dustfall, total particulate (irrespective of its chemical composition) and sulfur dioxide may be a general indication of the quality of a particular environment, they are not enough. Such an approach can lead to questionable cause and effect relationships between the increased incidence of a particular medical complaint and the presence of higher levels of these two pollutants. A recent study found that in order to get accurate indications of community exposure to sulfur dioxide, four monitoring stations per square mile would be required. If we were to specify these to be of the continuous monitoring type the expense would be considerable.

There is little doubt that increasing levels of toxic materials are bad for human health. There is, however, considerable doubt as to what extent these materials must be curbed to guarantee minimum future suffering. For no pollutant has a threshold been satisfactorily demonstrated, medically. For example, for radioactive substances and ozone the evidence against the existence of a level below which no harm occurs has prompted certain international bodies to warn of risk at any level.

We are not likely to obtain definite answers to questions such as how many more cases of bronchitis are caused for each additional ppm of sulfur dioxide. It is likely, though, that reducing the amount of sulfur oxides and many other harmful additives in the environment will result in improved health. Of all known pollutants only a few trace metals are known to be essential to the human body.

9.2 Individual Chemicals

In discussing the effects upon humans of particular pollutants, one must differentiate, if possible, between short high level effects and the long term low level symptoms. For example, a short high level of carbon monoxide can kill while at low levels visual acuity and loss of an appreciation of relative brightness as well as auditory discrimination are the usual symptoms. Another modifying statement is the difficulty in relating symptoms to their cause. Different pollutants, or indeed sources unrelated to environmental contaminants, can lead to comparable symptoms. It can take an expert medical diagnosis to pinpoint the origins of medical complaints. Headaches and stomach upset are very common symptoms.

9.2.1 Sulfur Dioxide

A 1969 study concluded 0.1 ppm sulfur dioxide over a 4 day period caused irritation only to sensitive people while 0.25 - 0.3 ppm sulfur dioxide caused a big jump in human susceptibility. Currently, the American Conference of Governmental Industrial Hygenists has established 5.0 ppm sulfur dioxide as an acceptable threshold for healthy persons exposed for an 8 hour period 5 days per week. This is well above the sensitivity threshold for green plants and also above the odor threshold of 3 ppm. Concentrations of 0.3 - 1.0 ppm can be detected by the average individual possibly by taste rather than odor.

The immediate effects of sulfur dioxide below a few ppm are negligible to most people. One ppm for 5 hours can cause bronchospasms in sensitive people, however, 400 - 500 ppm is immediately dangerous to life and 50-100 ppm is considered the maximum exposure for periods of 30 - 60 minutes.

Sulfur dioxide is rapidly absorbed by the nasal mucous membranes and thus interferes with the ability of the nose to expel unwanted substances. This action leads to breathing impairment. Sulfur dioxide also enters the lungs through the mouth and is absorbed on fine particles that are carried into the broncheoles. This gas is also dangerous to the eyes, as it causes irritation and inflammation of the conjunctiva.

9.2.2 Sulfuric Acid and Particulate Sulfate

Under certain atmospheric conditions sulfur dioxide has the potential to be oxidized to sulfuric acid or particulate sulfate both of which have their own toxicological effects.

Repeated or prolonged inhalation of sulfuric acid produces the same symptoms leading to chronic bronchitis as does sulfur dioxide. Normally 0.125 to 0.50 ppm may be annoying. The importance of this potential contaminant has not been assessed in the vicinity of sour gas plants.

Sulfur dioxide is easily absorbed and oxidized upon airborne particulate matter to form complex inorganic compounds of sulfur. Laboratory experiments indicate that if a given amount of sulfur in the form of sulfur dioxide causes a 15% increase in breathing resistance, then the same amount of sulfur as sulfuric acid can cause a 60% increase in breathing resistance. Furthermore, if the sulfur were converted to zinc ammonium sulfate particulate of 0.3 micron diameter a 300-fold increase in breathing resistence can be expected. Even though these experiments were performed on guinea pigs, the results indicate that response to pure sulfur dioxide is not a proper basis for consideration of its role as a pollutant since the sulfur toxicity of various compounds does not appear to be simply additive. Put another way, the factor of importance brought out by this research is whether the response to sulfur dioxide, in this case, can be intensified by its inclusion in an aerosol particle as sulfate or by its solubility and conversion to sulfuric acid in rain droplets. The answer would seem to be affirmative for either case.

9.2.3 Hydrogen Sulfide

The present air quality standards prescribe 0.005 ppm as the acceptable background level for hydrogen sulfide over a twenty-four hour period. It has further been specified that all hydrogen sulfide should be converted to sulfur dioxide before admission to the environment, as sulfur dioxide has a higher odor threshold than hydrogen sulfide. No other stated reason can be found. The scientific literature is confused as to what level is detectable by the human nose; values of 0.03 ppm and 0.78 have been suggested, the former being the same as the current one hour standard. Fifty ppm is said to cause severe eye irritation, 100-150 ppm paralyses the olfactory senses and 700-800 ppm for 30 minutes will result in death. The toxicity of hydrogen sulfide approaches that of cyanide. Its mode of action is similar. Hydrogen sulfide and other sulfides act by fixing the iron in cytochrom A_3, thus reducing the subject's ability to take up oxygen. This leads to paralysis of the respiratory centre. As with carbon monoxide poisoning, sublethal doses are reversible as artificial respiration and oxygen therapy can restore normal breathing. The symptoms are nausea, dizziness and headache. Repeated exposures to low concentrations of hydrogen sulfide (unspecified) lead to conjunctivitis, pain in the eyes and blurred vision.

Again, the American Conference of Government Industrial Hygenists accepts 10 ppm hydrogen sulfide as the threshold level, which is that level below which no health impairment is expected, for an 8 hour working day. In this context it is well to recall the same group suggests 5.0 ppm as a similar level for sulfur dioxide.

9.2.4 Other Substances

Hydrogen sulfide and sulfur dioxide are the principal malefactors associated with sour gas processing plants. Pinpointing less obvious deleterious compounds will require further investigation. Many complaints have been made of unpleasant odors in the vicinity of gas plants not attributable to sulfur dioxide or hydrogen sulfide. Attempts to isolate the responsible chemicals is an arduous task and so far has had little success. Among the possible pollutants (or groups of chemicals) which have already been associated with the operation of sour gas plants are the following:

9.2.4.1 Carbonyl Sulfide (COS)

In high (unspecified) concentration considered to be a narcotic. May produce hydrogen sulfide, sulfur dioxide or even mercaptans and other sulfur containing compounds upon decomposition in the presence of organic vapors.

9.2.4.2 Carbon Disulfide (CS_2)

A threshold limiting value of 20 ppm for an 8 hour day and 40 hour week is specified. Above this value extremely toxic leading even to insanity and personality changes.

9.2.4.3 Selenium

Selenium in small amounts is essential for normal growth and health of some animals. As an element it has a low toxicity. Where the element is chemically combined with organic residues greater toxicity may result because of the higher vapor pressure of organoselenium compounds.

9.2.4.4 Lead

Lead poisoning is one of the commonest of occupational diseases. Lead is a cumulative poison. Increasing amounts build up in the body until eventually symptoms appear. The symptoms and toxicology are extensive and well documented. It takes an expert to diagnose. In cases of lead poisoning findings in excess of .07 mg of lead per 100 cc of whole blood are common.

9.2.4.5 Phenols

A threshold limiting value of 5 ppm in air is given. Chronic poisoning following prolonged exposure to low concentrations (unspecified) result in digestive disturbances.

9.2.4.6 Glycols

Most glycols have low volatility and hence present little danger to humans. Severe poisoning can result from drinking glycol contaminated water, for example, from settling or waste water ponds.

9.2.4.7 Heavy hydrocarbons

The toxicity depends on the specific material. Substances such as Benzpyrene have been incriminated as cancer causing agents in urban atmosphere. No limits are available.

9.2.4.8 Mercaptans

Mercaptan is a class name for any of a large group of organic compounds having a very offensive odor and containing sulfur bound to a hydrogen atom. While mercaptans are trace components in raw sour gas, they by no means exhaust the number of possible sulfur containing organic compounds of even lower odor threshold that may also be present in the raw gas. Among others, mercaptans are even re-introduced as odorizers to the sweetened gas before it is allowed into the home.

Since it may be unnecessarily restrictive, perhaps undue attention should not be directed to mercaptans until their involvement as noxious emanations from the processing plant has been definitely proven.

Nevertheless, as an example, a threshold limiting value of 0.5 ppm has been put forward for ethyl mercaptan (ethane thiol).

9.2.4.9 Mercury

As a result of a concern expressed by the Alberta Fish and Game Association at two public hearings in August of 1971, that harmful amounts of mercury could enter the biosphere by the processing of gas which may contain trace quantities of mercury, the Energy Resources Conservation Board initiated a study into the mercury content of Alberta reservoir fluids. Samples of gas, condensate and formation water were taken from several gas and oil pools in the Province. These samples were analysed by the Department of the Environment Pollution Control Laboratory using flameless atomic absorption methods.

Mercury was not detected in most samples analysed. The highest mercury concentrations detected in the gas, condensate and formation water samples were 1.5 parts per billion by weight (ppbw) in gas from the Elkton Shunda formation of the Brazeau River Field, 45 ppbw in condensate from the Beaverhill Lake formation of the Kaybob South Field and 40 ppbw in water from the Viking formation of the Provost field. These maximum detected concentrations are equivalent to approximately 0.1 pounds per billion cubic feet of raw gas, 10 pounds per million barrels of raw condensate and 14 pounds per million barrels of formation water.

If it were assumed that fluids containing these maximum detected concentrations all could occur in one gas reservoir, and that the reservoir would be the source of supply to a gas plant processing 400 million cubic feet per day of raw gas, 10,000 barrels per day of condensate and 100 barrels per day of produced water, the total mercury entering the plant at the maximum inlet capacity would be approximately 0.14 pounds per day. Any mercury emission from the plant would probably be much less than the amount entering since most of the fluids would be contained and would not be released to the surrounding environment.

It is significant to note that in the United States the Environmental Protection Agency (EPA) has proposed that the maximum mercury emission permitted from one plant is 5 pounds per day. This would, the Environmental Protection Agency believes, maintain safe environment concentrations. A Canadian emission standard has not yet been established.

In specific areas such as Pincher Creek some of the above substances have been sought for in air, water and soil samples by various government and private agencies. Their results have been less than unanimous in establishing that a particular chemical was present in the environment at concentrations considered to be potentially harmful to life over even an extended period of contact. The Department of the Environment does not perform tests for any or all of the above potential pollutants on a regular basis.

9.3 In-Plant Environment

So far environmental health has been discussed in terms of the community outside the confines of the gas processing facility. However, one should not overlook the occupational environment of the employees on the lease or in the plant, as the concentration of hazardous chemicals resulting from an accident or plant upset may exceed by orders of magnitude those experienced by the community at large. Health standards assumed for the employe differ considerably from those for the rest of the community. Indeed, threshold limit values of 10 and 5 ppm for hydrogen sulfide and sulfur dioxide, respectively, for an eight hour day, five days a week, seem to bear little relation to the Ambient Air Quality Standards for the province, exclusive of the plant.

In contrast to the network of sulfation cylinders and mobile continuous monitoring devices off the plant site, in-plant monitoring equipment is more qualitative than quantitative. Indicator tubes whose color changes relate to various hydrogen sulfide and sulfur dioxide levels (within 25%) are consulted after plant personnel detect by odor what to them seems an unusually strong smell of hydrogen sulfide or sulfur dioxide. Safety alarms which announce approach to a potentially explosive mixture of hydrogen sulfide and air or hydrocarbon and air may be found in compressor buildings and around equipment capable of setting up static electric charges or generating sparks. Concentrations of hydrogen sulfide or hydrocarbons which constitute near explosive mixtures with air are well in excess of the concentrations considered injurious to human health.

In touring the plant premises it is not possible to ignore the periodic, transitory whiffs of hydrogen sulfide, sulfur dioxide, or other unidentifiable odors which presumably are well below toxic levels. Yet there would seem to be no detection equipment on the plant site, outside the buildings, which would confirm such a supposition. Inside plant buildings breathing hoses are provided, usually enough for two persons, for those cases where it becomes necessary to enter, or work, in an area of extreme hazard. In areas of incessantly high noise ear muffs are made available. Where noise is a problem the facility is generally completely automated and isolated so that operators need only make periodic inspection passes through such buildings.

Again, while the plant normally does not conduct its own noise level surveys on a regular basis, periodic checks are made by the staff of the Energy Resources Conservation Board.

It is not feasible nor reasonable to regulate health and safety on an industry-by-industry basis. This is evidenced in the functioning of the Division of Industrial Health Services of the Province, where regulations are established by diseases, such as lead poisoning, acceptable noise levels of compressors regardless of industry, carbon monoxide levels, etc. It seems to be

Industrial health statistics are normally complicated by the high degree of worker mobility which makes it difficult to keep continuous medical histories. A person's medical history doesn't follow him from job to job. Incidents of job-associated illness are also not traceable unless a claim has been made to the Workmen's Compensation Board.

There is even more cause for being disturbed when it is realized that in Alberta there are only four people trained in industrial hygiene for work within a plant and all of them are in Edmonton. We should feel fortunate, for there are only eleven in Canada. In Alberta there is only one inspector of occupational health and no legislation enabling him to enter company premises except at the invitation of the plant operator or manager.

9.4 Human Factors

The relationships that prevail among individual processing plants and members of the surrounding community are varied and one could easily paint too simplistic a picture of this interdependence, for that in great measure is what best sums up the respective roles - interdependence.

On the one hand evidence of previous grievances and accidents sometimes implants an attitude akin to hysteria in people faced with the realization that a sour gas processing plant is to locate in their vicinity. The plant then bears the blame for every possible mishap, illness or indisposition suffered. There have been instances where success with an initial legitimate complaint against a plant has been the impetus to placing every subsequent problem with field crops and livestock at the door of the gas plant. This has led to a final hopeless resignation such that no further effort is made to maintain farm management.

On the other hand it is also possible to see farmers working land within one hundred yards of sulfur piles or to watch prize-winning cattle and Arabian horses grazing within sight of processing plants. Some may be prompted to thoughts of sheer folly; nevertheless, it is a common occurence. In some instances local people supplement their farm income by working at the sour gas plant, using farm vehicles to get to and from the job. These people provide excellent, though indirect, public relations for plant owners and a buffer between the plant and more opinionated residents.

Plant personnel, on their side, have individually been commendable citizens of their local communities. Some have been instrumental in bringing to moribund central Alberta towns a renewed vigor through participation in such diverse projects as upgrading of local recreational facilities, sitting on local school boards and even writing local histories.

Often, of course, public relations between the local farm community on the one hand and corporate bodies, including government agencies, on the other has not been as good as it could be, mainly, it would seem, because the value of good public relations has been severely under-rated. Many problems and attitudes could be avoided or at least lessened if interactions between these groups had been more direct.

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PART 10

EFFECTS OF POLLUTANTS ON FARM LIVESTOCK

10.1 General Remarks

On a number of occasions in past years veterinarians of the Department of Agriculture have been called upon to assist with investigations of reported damaged to farm livestock thought to be the result of activities associated with sour gas processing operations. Complaints have been of a varied nature depending for the most part on the manner in which the animal encountered the source of toxicity. Where the state of illness has been thought to result from airborne sulfur containing chemicals, the most common diagnosis is one of damage to the lungs (pulmonary emphysema) or irritant damage to the eyes resulting in inflammation and even blindness. Livestock owners insist high local gas concentrations result from unique weather and geographic conditions and in so doing illustrate the importance of episodic events in contrast to violation of any long term air quality prescription. In fact, compensation was awarded to an owner of swine shown in one specific instance to have died as a result of lung damage.

Cases of sulfur spills or blowing sulfur dust in livestock drinking water, animals dying after having access to plant waste effluent treating ponds also have been reported. In numerous instances the cause and effect sequence has been so well proved that recompense is made to the affected party. In still other cases compensation has been made by the plant operator as an apparent token of goodwill to the local inhabitants where injury or mortality could not be directly connected with any gas plant procedure. The prospect of a possible financial settlement from a large plant has played its own role in the attitudes of some local inhabitants.

From these brief remarks it can be inferred that complaints against sulfur plants are many and varied. Definitive diagnoses of injury are hard to obtain, partly because it is so difficult to perform autopsies on enough specimens and quickly enough to positively identify the cause of death. There is indeed a general lack of knowledge about the effects of these various gases, effluents and lubricants upon not only livestock but all members of the biosphere.

As well, some very complex relationships may arise such as the possibility that, as a result of gas plant emissions or for some unrelated reason, local ecology changes: new animal forage or weeds may enter an area, one of which is able to concentrate within its edible parts chemicals from the soil which, when ingested in sufficient quantity, cause livestock mortality or sickness. Such synergistic effects are unforeseen and never considered, yet they do occur and are immensely difficult to track down or predict.

10.2 Research

Several years ago the Veterinary Services Division of the Department of Agriculture and the Department of Health conducted a project which consisted of exposing animals, such as rabbits, guinea pigs, and small domestic pigs, to various levels of hydrogen sulfide and sulfur dioxide, alone and in combination, for varying periods of time. Certain levels were demonstrably harmful and the damage appeared to be restricted to the respiratory system. Data was published by Dr. J.G. O'Donoghue.

A current task of the Veterinary Services Division has as its purpose the evaluation of the incidence of atypical interstitial pneumonia in Alberta cattle with particular reference to gas processing plants. This disease was present in Alberta before gas processing plants were here but an effort will be made to determine if there is a relationship to the geographic area of gas plants. It is a disease which has a seasonal incidence, usually being observed in late August or early September. It has multiple causes, some unexplained, and it seems possible that irritant gases could be involved in some outbreaks.

The element selenium has received wide attention lately, partly, perhaps, because it has chemical characteristics similar to those of sulfur, and may perhaps be present at low levels as hydrogen selenide (H_2Se) escaping from plant operations. Deficiency or excess of elemental selenium is associated with serious disease in livestock. White Muscle Disease occurs in calves and lambs as a result of selenium and/or Vitamin E deficiency. Certain areas in the province are known to have selenium deficient soils. Concern has been voiced as to whether sulfur in the soil could inhibit the uptake of selenium by plants, from which it is made available to the animal. Problems such as these are receiving current research support in Alberta.

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PART 11

POLLUTANT EFFECTS ON VEGETATION

11.1 Pollutants and Vegetation

A number of chemicals commonly associated with polluted atmospheres are required by economically important vegetation for growth when applied at reasonable levels and in the proper form. Plants require a certain amount of sulfur in the form of sulfate taken up through the roots. It is also possible that this sulfur may be taken up through the leaves as sulfur dioxide.

D. L. Massey and P. J. Martin (Edmonton Journal, May 4, 1972) in a study on the role of selenium in plants and animals, suggest that this element is vital to plants and animals and that soils in west central Alberta are potentially selenium deficient. Some forms of vegetation in Alberta have even been found to concentrate selenium in their leaves.

Certain Alberta grey wooded soils have been shown to be sulfur deficient and would benefit by addition of sulfur. The hydrocarbon ethylene (C_2H_4) has been used as a plant growth hormone at low levels.

An additional interesting fact is the lack of visible injury to even the most sensitive plants upon 5 hour exposure to levels of hydrogen sulfide up to 40 ppm! As it is a local problem, not of national importance, the plant toxicology of hydrogen sulfide has not received sufficient attention. Other sulfides such as calcium sulfide, sodium polysulfides, and even elemental sulfur have been used as fungicides and are known to be toxic to green plants especially at high air temperatures.

Notwithstanding these preliminary remarks vegetation, including many valuable crops and timber species, is sensitive to air pollutants. Furthermore, an expert is needed to determine whether indeed a chemical pollutant is involved at all. For example the toxic effects of excessive sulfur dioxide can be closely mimicked by several agents such as chlorine gas, hydrogen chloride, or nitrogen dioxide, not to mention frost, drought, insect diseases and some nutrient deficiencies. It is an unfortunate fact, but just those conditions of sunlight and high humidity which are conducive to plant growth also facilitate plant injury by these various polluting substances.

Plants of different species vary in their sensitivity to pollutants. It can be further remarked that the young actively growing stage for all species is most susceptible to damage. In this regard highly sensitive plants such as alfalfa, barley, clover and rye offer some possibility as indicators of sulfur dioxide. A certain species of lichen has been used in England as a bio-assay. All varieties of pumpkin and squash show markings when no other garden plants are touched.

11.2 Consideration of Individual Pollutant Symptomatology

11.2.1 Sulfur Dioxide

Sulfur dioxide absorbed through the leaves and plant tissue is converted to sulfite which is then oxidized to sulfate, the usual nutritional form in which sulfur is used by the plant. Excessive sulfur dioxide causes the concentration of sulfite to build up. It is because of its reducing potential that sulfur dioxide (or sulfite) is considered toxic to plants. Sulfur dioxide at 0.25 ppm, over a number of hours, causes injury to numerous pine and spruce species. Crop yields are usually not affected unless more than 5 - 10% of the leaf area has been destroyed. Synergistic effects have been observed after two hour exposure to sub-threshold levels of ozone and sulfur dioxide, or nitrogen dioxide and sulfur dioxide, for some species of plants. Although the plants tested are not commonly found in Alberta, it does suggest the possibility for research on species indigenous to the province.

11.2.2 Sulfuric Acid Mist and Sulfate Particulate

There have been few studies to determine whether these substances directly affect plants in nature. Thirty to sixty-five ppm of sulfuric acid for four hours failed to cause injury to alfalfa or sugar beets. These levels of sulfuric acid are presumably much higher than found in Alberta.

11.2.3 Hydrocarbon Phytotoxic Pollutants

Ethylene, while a growth hormone at low concentration (not specified), is cited as 100 - 1,000 times more toxic to plants than higher olefins. Ethylene plays a role in the aging of the plant. One ppm over a seven day period gives a visible response.

11.3 Other Considerations

Specific instances of crop damage in Alberta apparently are limited to a total of 100 - 300 acres in the immediate vicinity of sulfur stockpiles where complete soil sterility attributable to sulfur dust prevents the growth of anything but the hardiest weed. The cause and treatment of this type of calamity will be discussed below. Before proceeding to that subject additional comments have come from discussions with the provincial and federal forestry people. It is reasonable to include them at this point.

Basically, the sour gas industry is considered a clean one by those responsible for the province's "green-belt", that area in the foothills region not suitable for agriculture except perhaps for grazing. The majority of it is public or crown land in the various Rocky Mountain Forestry Reserves. So far no more than a total of about two hundred acres have been involved, notably around well sites where discolored vegetation is to be found. It is within the jurisidction of the Alberta Forest Service to see that abandoned well sites are restored. This does not include the thousands of acres cleared for the actual plant sites.

11.4 The Role of Forestry Agencies

Presently the Canadian Forestry Service is working with Aquitaine personnel at Ram River and the Gulf Strachan operation to measure the physiological effects on a wide range of vegetation which will probably experience a doubling in its sulfur dioxide exposure levels as a result of the proximity of the two processing operations. Coupled with this research effort will be a compilation of all research literature relevant to the effects of various industrial pollutants on vegetation, with specific emphasis on local species.

The Canadian Forestry Service is to add to their staff, nationally, some eighty surveillance personnel as their share in the national effort toward pollution control on forested lands.

The situation is not that encouraging, if one considers the gas transmission from well site to the plant, including the preliminary exploration stages. It has been estimated that about 10% of the Rocky Mountain Forestry Reserve cover has been removed in the development of exploration and seismic lines by the energy industries. The acreages involved per year are said to be approximately equal to the number of acres lumbered commercially per year up to and including 1970.

The Canadian Institute of Forestry (CIF) felt concerned enough for the fragility of our "greenbelt" to file a submission with the Energy Resources Conservation Board in opposition to the then proposed Ram River Aquitaine sour gas plant. While the grounds for this opposition were found to be adequately covered by existing provincial regulations, the cooperation between these companies and the Federal Forestry Department on plant physiology and toxicology studies in the area points to the relevance of the Canadian Institute of Forestry brief.

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PART 12

POLLUTANT EFFECTS ON SOIL

The Provincial Department of Agriculture and the University of Alberta have been cooperating with various gas plants in an effort to combat the sulfur dust problem adjacent to their plants. In most instances the processing plant owns most of the affected land and leases it to local farmers. How and why this is so, and what benefits accrue to plant and farmer are questions which are suggested by this circumstance. The new methods of slating and chipping elemental sulfur will go a long way to alleviating future dust problems. Presently very little loading of block sulfur is going on. Additionally, present levels of sulfur oxides in the atmosphere of central Alberta would seem to be contributing insufficient sulfur to eliminate any present sulfur deficiency which might exist in the area. Snow and rain analyses suggest that between two and six pounds of sulfur (as sulfate) per acre are being deposited annually in Central Alberta. Perhaps as much as ten times more sulfur oxides are taken up by the soil through direct absorption than are contributed by precipitation.

Soil has a remarkable capability to accept and decompose vast quantitities of waste materials. The question of soil pollution is vastly different than air or water contamination. Complex chemical and biological processes, when not over-burdened, can be utilized in the soil to dispose of many common pollutants.

12.1 Formation Water and Chemicals

Oil and salt water spillage during exploration and production of oil and natural gas was a big problem. Salt water effects are more difficult to correct than oil spills. Salt water contains sodium ion which causes soils to deflocculate or lose their structure. Thus, leaching of the salt is a very slow process. Sodium ion is also toxic to plants in high concentration. Most salt water is now pumped to disposal wells.

Installation of central pumping stations results in the abandonment of a number of battery sites. The spilled and burned crude oil around such sites can sterilize land for a number of years. Herbicides used around well sites have sometimes sprayed over to crop land causing localized soil sterility.

12.2 Sulfur Dust

Elemental sulfur dust is generated during sulfur block crushing and loading operations at the gas processing plant. This dust may be blown a short distance downwind, confining soil damage to within approximately one mile of the plant.

In the soil, sulfur dust is oxidized to sulfuric acid at a rate dependent upon the type of soil, temperature, moisture and fineness of the deposited dust. This oxidation process is carried out by certain soil bacteria, which, given the proper conditions, are capable of converting up to 1,000 tons of sulfur per acre per year. Sulfuric acid so produced will acidify most soils to the extent that vegetation is harmed and even dies. Damage to vegetation is usually apparent after two or three years of regular exposure.

Most natural soils in Alberta have pH values from 6 - 8. When soil pH goes below 5.5 aluminum and manganese ions, which are toxic, become available to the growing plant. Hence the concern over sulfur dust.

As an example, about 3 acres had been made completely barren by soil acidification, with an additional 2 - 3 acres acidified to the extent that crop growth was poor. Soil pH in the barren area ranged from 3.1 - 4.6. Crop growth had been absent from the area for 5 - 6 years, with the area only able to support Canada thistle and quack grass. Water erosion had removed much of the topsoil, leaving a soil low in organic matter and of poor structure.

Successful reclamation of this plot and others like it have been achieved through the use of liming procedures to bring the soil to near neutrality (pH 7). For soils of pH 5 and less this has required application of up to 3 tons of calcium carbonate per acre. It has been suggested that upwards to 200 acres have been affected to varying degrees by sulfur dust in Alberta. In the instance cited above cost of reclamation was over $300 per acre, including lime, its application and turning into the soil, and the laboratory analyses of the soils. In some cases the value of the land may not justify such expenses.

Since soils have a great capacity for absorbing sulfur dioxide there is great concern locally that a gradual fall in pH will be observed over the years with the attendant consequences outlined above.

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AMBIENT AIR QUALITY STANDARDS

PROVINCE OF ALBERTA

AMBIENT AIR QUALITY STANDARDS FOR ALBERTA

The purpose of this outline is to establish minimum acceptable standards of ambient air quality to protect the health and welfare of all citizens, enhance and maintain the quality of the Province's air resource and prevent insofar as possible deleterious effects to animals, plants and property.

DEFINITIONS:

(1) **Ambient Air Quality Standard:**

The numerical expression of pollutant limitations in the ambient air to minimize deleterious effects on human, plant or animal life and welfare. The standards consist of two parts — a specified concentration level for a particular air contaminant and the time-averaging interval over which that concentration level is measured.

(2) **Standard Conditions:**

For the purpose of this outline, all measurements and calculations shall be referenced to a temperature of 20°C and a barometric pressure of 760 mm. of mercury, where applicable.

AMBIENT AIR QUALITY STANDARDS

The following ambient air quality standards as tabulated are applicable to all areas of the Province of Alberta unless otherwise indicated. The ambient air quality standards are specified in Table I

The maximum calculated ground level concentration standards utilized in the air management for pollution control and designated in consideration of the ambient air quality standards are tabulated in Table II The applicable ground level concentration calculations will be the latest Provincial Board of Health approved calculation methods. Where two or more point sources are located in close proximity the maximum ground level concentration shall take into account the cumulative effect of all sources.

The ambient atmospheric concentrations of all substances not specified herein shall not exceed levels considered deleterious to human, plant or animal life and welfare as established by the control authority

METHODS OF MEASUREMENT

(1) Air pollutants shall be measured by the method or methods listed in Table III or by any other methods approved by the Provincial Board of Health.

(2) A minimum of three-quarters of the total possible readings for each specific time averaging period, shall constitute a valid representation.

(3) Annual averages shall be determined on the basis of any consecutive twelve month interval beginning on the first day of December.

ABBREVIATIONS USED IN THIS REGULATION

°C = degrees centigrade
cm. = centimeter
coh = coefficient of haze
gm. = gram
hr. = hour
l. = liter
m. = meter
mm. = millimeter
mg. = milligram (10^{-3} gm.)
mi. = mile
min. = minute
mo. = month
ppm. (vol.) = parts per million (volume basis)
ppm. (wt.) = parts per million (weight basis)
sq. = square
µg. = microgram (10^{-6} gm.)

TABLE I
AMBIENT AIR QUALITY STANDARDS

	POLLUTANT	CONCENTRATION UNIT	AVERAGE CONCENTRATION FOR APPLICABLE TIME PERIOD			METHOD OF MEASUREMENT
			1 HR.	24 HR.		
1	FLUORIDES (as HF)	ppm (vol.)		0040		Spectrophotometry
		mg/m^3		.0033		
	FLUORIDES in forage for livestock (dry wt. as F)	ppm. (wt.)			35.0	Gravimetry
		mg/l			35.0	
2	TOTAL OXIDANTS (as O$_3$)	ppm (vol.)	.15	.10	90% of readings per month < .07 ppm. (vol.) (.137 mg./m^3)	Spectrophotometry
		mg/m^3	.29	.20		
3	TOTAL OXIDES OF NITROGEN (as NO$_2$)	ppm (vol.)	30	.10		Spectrophotometry
		mg/m^3	56	.19		
4	CARBON MONOXIDE (CO)	ppm (vol.)	60.0		8 hour average 15.0 ppm. (vol.) (17.2 mg./m^3)	Infrared Spectrophotometry
		mg/m^3	68 7			
5	HYDROGEN SULFIDE (H$_2$S)	ppm (vol.)	030	005		Light transmittance or reflectance
		mg/m^3	042	.007		
6	SULFUR DIOXIDE (SO$_2$)	ppm (vol.)	30	.10		Conductivity
		mg/m^3	.79	.26		
7	SOILING INDEX	coh	90% of average readings per month < 1.0		Annual Average < .45	Light transmittance or reflectance

POLLUTANT		CONCENTRATION UNIT	AVERAGE CONCENTRATION FOR APPLICABLE TIME PERIOD			METHOD OF MEASUREMENT
			1 HR.	24 HR.		
8	SUSPENDED PARTICULATES	µg m		100		Gravimetry
9	TOTAL DUSTFALL*	tons/sq. mi./ 30 days			15.0 residential area 45.0 industrial and commercial area	Gravimetry
		mg /cm.^{2}/ 30 days			0.525 residential area 1.575 industrial and commercial area	
			*due allowance shall be made for normal background levels			

TABLE II

MAXIMUM CALCULATED GROUNDLEVEL CONCENTRATION STANDARDS

POLLUTANT		CONCENTRATION UNIT	MAXIMUM ACCEPTABLE CONCENTRATIONS FOR APPLICABLE TIME PERIOD		LAND USE
			30 MINUTE	OTHER	
1	SULFUR DIOXIDE	ppm. (vol.)	.2		urban and arable agricultural areas
	SULFUR DIOXIDE	ppm. (vol.)	3		all other areas (1)
	SULFUR DIOXIDE	ppm (vol.)		1.0 (2)	all
2	HYDROGEN SULFIDE	ppm (vol)	01 (3)		all
3	OXIDES OF NITROGEN AS NO_2	ppm. (vol.)	2		urban
	OXIDES OF NITROGEN AS NO_2	ppm (vol)	3		rural
4	FLUORIDES as HF	ppm. (vol.)	01		all
5	AMMONIA	ppm. (vol.)	2 0		all

Footnotes

1. In forested areas due allowance must be made for height of trees for stack height calculations
2. To be utilized for short period emergency flaring only (less than one hour)
3. Where incineration is feasible, the H_2S must be incinerated to SO_2

TABLE III

METHODS OF AIR CONTAMINANT MEASUREMENT

	AIR CONTAMINANT	SAMPLING METHOD	SAMPLING INTERVAL	ANALYTICAL METHOD*
1	PARTICULATES			
	Suspended	High Volume Filtering	24 hours	Gravimetric (Air Pollution Measurement of the National Air Sampling Network, 1957-61, U.S. Dept. of Health, Education and Welfare, Cincinnati, Ohio, pp. 6-8, 1962)
	Settleable	Dustfall Jar	30 days	Gravimetric (ASTM D 1739-62)
	Soiling Index	Spot Tape Filtering	2 hours	Light transmittance (Hemeon, Haines and Ide, Air Repair Vol. 3, pp. 22-28, 1953)
2	SULFUR DIOXIDE	Conductivity	continuous	Electrical conductance and ionization
3	HYDROGEN SULFIDE	Spot Tape	1 hour	Light transmittance, lead acetate impregnated tape, (Sensenbaugh, J.D. and Hemeon, W.C.L., Air Repair Vol. 4, p. 5, May 1954)
4	CARBON MONOXIDE	Optical	continuous	Infrared Absorption (Air Pollution, A.C. Stern ed., Vol. 2, pp. 433-434, Acad. Press. 1968)
5	OXIDANTS	Volumetric	continuous	Colorimetric, Neutral Potassium Iodide Method (ASTM D 2011-65) Coulometric, Neutral Potassium Iodide Method
6	OXIDES OF NITROGEN			
	Nitrogen Dioxide	Volumetric	continuous	Colorimetric Saltzman Reagent
	Total Oxides of Nitrogen	Volumetric	continuous	Colorimetric—Saltzman Reagent
7	HYDROGEN FLUORIDE	Volumetric	continuous, 2 hour or 24 hour	Colorimetric, SPADN Method (Bellacke and Schouboe, Anal. Chem. 30; p. 2032, 1958)

* Subject to revision by the Provincial Board of Health

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QUESTIONING BY THE AUTHORITY

DR. W.R. TROST

Would Dr. Smith have questions for clarification?

DR. S.B. SMITH

You mentioned the problems that are not easy to solve because of the complexities. From what you have seen of the plants you visited and the one that you know most about, how strongly do they depend on the skill of the worker in the plant to maintain the actual ambient conditions that are looked for ideally?

DR. R. KLEMM

Well again, this is simply a personal conversation. The control rooms of these plants remind me of what I think Cape Canaveral would look like. As for the intricacies of the technology of operating the plant, I would say that the plants I have seen are very sophisticated ones. The very large ones have facilities for telemetering results for monitoring stations directly to the plant, and facilities there for them to achieve essentially instantaneous control on the tail gas. They can then change air to H_2S ratios at the front of the plant. Obviously they don't do this instantaneously, but I would say that the industry as a whole is extremely labour unintensive but technologically very intensive. It takes very few people to operate the plant, therefore the worker has to be highly trained and come up through the ranks. I think it is a push button sort of operation.

MR. W.A. FLOOK

Dr. Klemm, I would like to explore the business of controls a little bit. You mentioned that sour gas is a relative term indicating that there are a variety of strengths of impurities that classify a gas as sour. Can you give us some idea as to what the range of H_2S and CO_2 is in these various gases?

DR. R. KLEMM

Well, again plant operation can depend a lot even on what the ratio of CO_2 to H_2S is or can be. Sixteen to a hundred and sixty parts per million, such as you use right in the home, would be considered sweet gas. The gas in the well can be as high as 75 to 80%, but I don't think that there are any plants that are operating on higher than say 55 or 60%. In other words, they would blend the gas for the plant.

MR. W.A. FLOOK

But the controls that are applied to the recovery of sulphur are based on a percentage recovery. Is that correct?

DR. R. KLEMM

That is right.

MR. W.A. FLOOK

In other words, the fellow who is processing a very sour gas is allowed by controls to put more sulphur into the air while complying with the recovery percentage than a plant processing a sweeter gas. Is this true?

DR. R. KLEMM

Yes.

MR. W.A. FLOOK

Thank you.

DR. W.R. TROST

Dr. Klemm, another line of questioning that we'll continue to explore is concerning those effluents and those products that can move out either from the plant itself, or from any other part of the system as the sour gas is taken from the ground to the customer, and which might have an effect on the environment of any sort.
Granted that the environment might be inside the plant (and there may be certain things that have effects there or partly there), there may be other things that get outside the plant and affect the environment. Can you tell us something about the major effluents that have environmental effects, that can be associated with the operation of getting sour gas from the ground to the customer?

DR. R. KLEMM

Without going into it in sort of regular fashion, I think the most obvious one is the SO_2 out the stack, which represents sulphur which can't as yet be recovered. There's the H_2S and SO_2 from flare stacks and certainly from leaks in pipelines. There is the produced water from the field. In other words, the gas comes in through a pipeline in essentially a three-phase system. You have hydrocarbon and water which contains salt and which is saturated with H_2S and CO_2. This certainly is a source of pollution. There are the chemicals used in the plant which go to storage ponds or evaporation ponds. There are spent catalysts which are either distributed around the plant site, or used as road gravel, or sold and reprocessed. There are obviously leaks of H_2S, for example, from the liquid sulphur. Incidentally the way the regulations read, NO H_2S is to be vented to the atmosphere. It must all be burned to SO_2, but obviously that's never happened. Certainly in the pouring of molten sulphur H_2S is vented. There's certainly some surface run-off around sulphur blocks and sulphur piles. There's the sulphur dust which has, in the past, been quite a serious problem, and which has been partially solved by the slating, but not totally. All these are definitely potential sources or have been

serious sources of environmental damage.
As for the in-plant environment, I would say the monitoring facilities in the plant are not at the same degree of sophistication as they are for the community as a whole. This brings up some rather interesting inequalities in the way these standards are set up, and presently monitored. Certainly, as far as the in-plant is concerned, to one not normally working in the plant, the noise of compressors seems to be extremely high; and although this is essentially an automated area in which people don't normally spend much time, they are extremely noisy places.

DR. S.B. SMITH

In the surveys that you and Dr. MacDonald did of the plants, you spent a week essentially at one plant. I wonder if you could just inform the Authority as to the cooperation you received from the plant officials as well as the workmen in the plant. Were you given the access to look at what you needed to look at?

DR. R. KLEMM

Very definitely; there was no hindrance of any kind. We could ask any questions we wished. We could visit any of the people in the community. In many instances we were not even supervised but just allowed to walk and talk to whomever we wished to talk to.

DR. S.B. SMITH

In your survey then, do you feel confident that you have been able to gain as reasonable an understanding of the complexities as a person who is not employed specifically in a plant? Do you think you have been able to get enough evidence to give a comprehensive look to people who attend these hearings as to what the present sulphur scene or gas sulphur recovery is in these plants?

DR. R. KLEMM

That is a loaded question.

DR. S.B. SMITH

I just mean a reasonable . . .

DR. R. KLEMM

I think that we have just about the finest overview with regard to the sources of information that we have had at our disposal as one could get in the time given for this purpose.

MR. W.A. FLOOK

You mentioned that plants differ apart from the size. In what way does one plant differ from another? In what way is one plant significantly different from another?

DR. R. KLEMM

The first thing that one is struck with is the fact that the plant sizes do differ. This is really the source of a lot of this difference. Large plants have a much higher percentage recovery. They are dealing with a lot more material. They have much more, I will use the term, exotic facilities to cope with all of the potential environment contaminants that I have mentioned, such as: the number of settling ponds, how they treat their run-off water, how they isolate one facility from another, the noise involved and how they segregate the various waste products into settling ponds of different kinds.

MR. W.A. FLOOK

It is also proved that the raw material varies quite considerably?

DR. R. KLEMM

That is quite true, and in the designing of the plant this is a very crucial point. One plant can have half a percent CO_2 and 20% H_2S which requires an entirely different type of operation than one which has 20% CO_2 and 3% H_2S.

MR. W.A. FLOOK

When one looks at a gas plant, a dominant feature of it, as you mentioned, is the tall stacks that stick up in the air. You mentioned that there are two types of stacks: the flare stack and the incinerator stack. Would you mind telling us about the different functions of these two types of stacks and why they have to be different?

DR. R. KLEMM

Once again, I think that with the size of the plant and which particular plant you are talking about they may in some instances serve the same function. Generally speaking, the flare stack is a safety feature. At those times of year in which the catalyst has been spent, or there has been an upset in the plant and it is necessary to blow down gas lines supplying the plant, this material is sent to flare and burned there to put this material into the atmosphere in a potentially non-harmful way. The incinerator stacks are designed to emit whatever possible pollutant we are talking about to the community environment in a manner which meets the ambient air quality standard.

DR. W.R. TROST

If we were thinking of those materials that might get into the atmosphere, water or the ground, without going into great detail, what kind of materials are most likely and the most important?

DR. R. KLEMM

On a day-to-day running of the plant, I think that the most obvious ones are hydrogen sulphide and sulphur dioxide. Others which have received little consideration and may possibly be of significance are the heat losses of the plant and perhaps carbon dioxide and nitrogen dioxide. Again I think this depends on the functioning of the plant.

DR. W.R. TROST

Into the water?

DR. R. KLEMM

There are a number of materials possibly. There is a test for just those materials which would use up the oxygen normally used by the aquatic life of the stream to which that effluent is discharged. It is probably one of the most important considerations as well as whatever dissolved solids which are from this plant effluent as a result of its oxidation in the settling pond.

DR. W.R. TROST

On the ground?

DR. R. KLEMM

The most obvious thing perhaps, at the present time, is sulphur dust and probably any sulphur dioxide which has been converted to sulphate from the time it leaves the stack to the time it hits the ground. I think that these two items are of different degrees and are serious contaminants of the ground.

DR. W.R. TROST

Without going into great detail, you have described what sounds like quite a complex operation and I suppose that one would assume that in normal operations that controls are also very complex. Are they?

DR. R. KLEMM

Most definitely. The degree of labour saving devices or all those operations which essentially cut down the number of human hands involved in the operation is quite extensive. It probably is a very technology-intensive industry.

DR. W.R. TROST

In case things don't always operate in the normal way, are there also contingencies to take some kind of accidental occurrences?

DR. R. KLEMM

Besides the operation of flare facilities and so on, in the design of the plant which is submitted to the E.R.C.B. the plant must specify all these safety features, in the operation and what to do as a contingency to plant upset or an accident in the plant.

DR. W.R. TROST

Overall, those materials that can become effluents to the atmosphere, to the water or to the ground may have properties that are either harmful or are beneficial to the living processes.

DR. R. KLEMM

Very definitely. Many of these materials are not that well understood. I think the reasons for testing the ones which we are aware of are that they are potentially dangerous to human life or plants or the environment in some fashion.

DR. S.B. SMITH

Of the 152 producing plants, you mentioned that 42 recovered sulphur and 43 had no recovery. Are some of those non-sulphur-containing gases where no treatment is required at all -- totally sweet gases?

DR. R. KLEMM

There are 67 sour gas plants plus or minus a few, I suppose. There are 42 recovering sulphur, and of the 67 that means about 25 of them just flare it. Now, this can be from a very small percentage of H_2S combusted to SO_2. It may conceivably even be CO_2 since a sour gas contains CO_2 and NH_2S in varying percentages. You may have 15% CO_2 and this may be treated in this way.

DR. S.B. SMITH

Can you tell the Hearing what the basis is for a permit for flaring only, where treatment or recovery is not being affected. Is it the absolute amount, or is it the . . .

DR. R. KLEMM

As I recall it, there is some regulation as to the percentage of H_2S over a certain percentage. One percent, let's say, has to be flared. Perhaps another recovery method, either glycol or a dry absorbent, is used for lower amounts. But certainly, all these gases contain certain amounts of H_2S. It may be a very few parts per million.

DR. S.B. SMITH

You stated here that the knowledge obtained by companies since 1947 has increased dramatically. That is, they have learned a great deal through experience and operating expense. Has there in your opinion been a concurrent improvement in the technology to minimize pollution?

DR. R. KLEMM

I think there has been a tremendous increase in the technology. It's just an expensive process, and it's a question of whether people will have to pay for this somehow, but there has been a tremendous increase in technology in this area.

DR. S.B. SMITH

In your report you deal quite extensively with various aspects of environmental pollution, but there is no section at all on water pollution. Is there no water pollution at all resulting from the operation of gas plants?

DR. R. KLEMM

The fact that the Department of the Environment has a water pollution branch and the fact that the industry does submit these data to the government would imply that there is obviously some sort of problem that needs regulation. The cases of water pollution, to my knowledge, were very few. Where one could say so many fish were killed -- and certainly there have been individuals who have brought forth complaints to the Department of the Environment and the Energy Resources Board on just these problems -- this has certainly led to the establishment of the standards that we have now in water quality.

DR. S.B. SMITH

I'd like to pursue this just a little. There are federal statutes involved in water pollution, both the Canada Water Act and the Canada Fisheries Act. I was wondering whether the problem was small because the water-borne effluents are very small and therefore fairly easily treated, or what. I'd like this point to be cleared up if possible. Are there very small amounts of aqueous effluents?

DR. R. KLEMM

I think that there is quite a bit of aqueous effluent. I think that I mentioned a sample from one plant in the report; I don't recall the figures offhand as to how many gallons of process water are emitted from the plant. The problem here is that these data which the plant is required to take are turned over to the Department of the Environment. There's very little they can do with them until the recent Clean Water Act is finished being gone over again, except in cases of violation to turn these data over to the Fish and Wildlife people for prosecution under federal legislation. So there have been problems in this area. It is obviously being cleared up and being looked after now. The legislation certainly has been tightened up in this area.

MR. W.A. FLOOK

Dr. Klemm, you indicate that the Department of the Environment sets the standards and the Energy Resources Conservation Board enforces them. Maybe you'd like to expand a little, particularly with regard to sulphur and sulphur compounds, as to how those standards are stated, and what the procedures are for monitoring them and complying with them.

DR. R. KLEMM

Each plant to my knowledge has a recovery efficiency depending upon its size and depending upon the quality of the gas it processes. It reports this recovery on a monthly basis to the Energy Resources Conservation Board in terms of a sulphur balance report. This report has to be submitted the month following that for which the data apply. Now, this report is a very extensive thing. It's double-barrelled in the sense that there is a double check on it; in other words the plant is required to tell how much sulphur it has produced as elemental sulphur, how much sulphur is in the condensate, how much sulphur goes to flare, what the H_2S content of their raw gas is, and how many million cubic feet they have processed during that month. In this way, although I can't picture exactly all of the columns in this report, there are enough data there to give the Board a very good indication as to how the plant is operating.

MR. W.A. FLOOK

But it is in essence an operating report submitted by the plant, is that right? The analyses, the measurements, the calculations and everything are done by the plant, and the report is submitted to the Energy Resources Conservation Board?

DR. R. KLEMM

That's right.

MR. W.A. FLOOK

Is there any monitoring by the Energy Resources Conservation Board or its personnel on the plant site as a check?

DR. R. KLEMM

Not by their personnel. The monitoring equipment is part of the plant equipment; it is operated by plant personnel on a semi-yearly basis in most cases. The E.R.C.B. requires incinerator stack monitoring surveys, but these aren't part of the regular monitoring facility or operation.

MR. W.A. FLOOK

And this sulphur balance is a business of sulphur coming in and sulphur going out -- balancing each other, in essence?

DR. R. KLEMM

To a certain degree. In one sense there is the possibility of doing this by difference. In other words, you say that I have so much sulphur going in, and I have produced so much sulphur; the total has to be 100 percent so the difference has gone up the chimney. There is the possibility of this sort of thing, but as I said before there is something of a check and balance on this to the extent that if the sulphur inlet and your total summation afterwards of sulphur in condensate, sulphur produced, and sulphur up the stack differ by say more than 10 percent, there has to be some sort of an explanation involved here, too. Included as well in this sulphur balance report are daily maximum half-hour emission rates from the incinerator stack in terms of tons of sulphur.

MR. W.A. FLOOK

In essence, this mainly gives you an operating efficiency for the plant -- the figure indicating the efficiency with which sulphur is being recovered?

DR. R. KLEMM

That would be my understanding.

MR. W.A. FLOOK

Would you be in a position to say how this translates into air quality, simply?

DR. R. KLEMM

I don't think it can be . . .

MR. W.A. FLOOK

There seems to be a gap between this and air quality; maybe you could bridge that gap.

DR. R. KLEMM

Perhaps the only bridge that I see in my mind is the theoretical calculations which are made on stack calculations. You have a certain amount of plant data which go into the design parameters for the stack which then can be translated into a certain downwind concentration -- ground level concentration, ambient air concentration -- of pollutant. But again this is a theoretical thing; it's very conservatively designed. That would be my understanding.

MR. W.A. FLOOK

In other words, there is an accepted method by which figures from data obtained from the stack can be translated into terms of what happens in the air, what should happen in the air.

DR. R. KLEMM

I think what should happen in the air is perhaps better put.

DR. W.R. TROST

You were describing in your comments that although the processes in the plants are basically all the same, still there are some elements of the plant that have to be thought of as unique. Do you want to elaborate on the elements that contribute to the uniqueness of each plant?

DR. R. KLEMM

This became most obvious to us in going through the Waterton plant.

Here was a plant with a maximum design capacity of somewhere in the neighborhood of 3000 long tons per day. Certainly the percentage of H_2S in the raw gas wasn't what one could call excessive, yet simply the size of the plant, and to a certain extent its previous history, dictated that it have certain operations, certain stripping features in treating this raw gas to be sure that it removes essentially all the heavy hydrocarbons, all the H_2S, all the mercaptans in a number of processes that smaller plants wouldn't be required to have. Smaller plants wouldn't have the extensive settling ponds which a larger plant would have. One plant, depending on the percentage of H_2S versus CO_2, for example may use diethylamine as the sweetening fluid. The Shell Waterton plant uses sulfinol, which is a mixture of an isopropylamine, and sulfolane, another potential adverse chemical, or chemical which must be treated in some way, which has a degradation product which must go somewhere -- to a settling pond, a storage pit, or some other facility of this sort.

DR. W.R. TROST

Now, we are dealing here with systems that have chemicals that are not always a part of normal life, and we have listed many of them. These can have deleterious effects on the environment. In principle, the question is are there actual indications of deleterious effects?

DR. R. KLEMM

Here in Alberta?

DR. W.R. TROST

That's a good place to start.

DR. R. KLEMM

I think the mere fact that the Department of the Environment and the

Energy Resources Board do have a set of regulations which govern the industry must mean something to this extent. The other thing is that both of them maintain a complaint file which they deal with; again I think these are good indications that there have been things happening for which there has to be contingency legislation of some sort. I think obviously the Pincher Creek case is a case in point, where environmental damage of one sort or another has occurred which has required the attention of the government agencies and the plant.

DR. W.R. TROST

Now, one can indicate these environmental effects as to where they occur -- whether in plants, animals, humans or in inanimate areas. Referring to the complaints as the indication, as it seems to me you were doing, do environmental effects occur in any of these, or some of these or all of these?

DR. R. KLEMM

I think they occur in all of them. I think there have been cases of livestock deaths and medical complaints; although they haven't been directly attributed to anything in particular, the fact that symptoms are seen to be somewhat similar all the way from one end of the province up through this area does say something. Certainly a number of plants are spending quite a bit of money on reclaiming their plant site areas, as far as what has happened in the past with sulphur dust, so I think these are at least some examples.

DR. W.R. TROST

Now, in some cases, an excess of a particular chemical may produce good or bad effects, and in some cases a deficiency of the chemical may produce good or bad effects. In respect to sulphur, are there not cases in which sulphur may already be deficient in a soil, and then the introduction of sulphur in limited amounts presumably might in fact have a beneficial effect?

DR. R. KLEMM

I think this is generally the case in central Alberta, at least as far as I know. These soils in central Alberta are supposedly sulphur deficient, and as far as we know the sulphur which is emitted or which returns to the soil as sulphate isn't enough to make up for this sulphur deficiency. The farmers in this area are still adding artificial fertilizers in terms of sulphate.

DR. W.R. TROST

Is there any indication that there may be any other chemical deficiencies that are associated directly or indirectly with the sulphur problem?

DR. R. KLEMM

There has been some attention lately directed towards the chemical similarity between selenium and sulphur, and the effect of selenium deficiencies on plants, animals and humans. To some extent this is associated with the amount of sulphur in the soil. It is also to some extent associated with either the deficiency or excess of vitamin E.

DR. W.R. TROST

Now, in these matters, in which complaints may be raised and consequently attention drawn to certain things, how does the question of proof stand?

DR. R. KLEMM

I don't know whether the question of proof actually arises. In some cases there is definite proof -- for example, a cow has had access to a storage pit, or has had access to polluted water which is obviously on the plant site because that's where the animal has been found. In these cases proof is quite obvious. There are other cases of paint damage and obvious corrosion problems where proof, if not 100 percent, is fairly close to it; but on the other hand there are also cases where settlements have been made where the proof isn't as conclusive, and which have been done as much from the public relations point of view as anything else.

DR. W.R. TROST

So, in many cases there are indications, but many points are still open?

DR. R. KLEMM

I think that basically one has to take each case on its own merits.

DR. S.B. SMITH

Dr. Klemm, you mentioned in brief form the group of chemicals commonly referred to as NOX's, the nitrogen oxides, but you didn't say what might be formed, or what is known about this particular group of chemicals in the incinerator stack. Is there any information on this? Has there been research to document the formation of the various nitrogen oxides?

DR. R. KLEMM

There has been a lot of work in this area in the case of steam power plants but I think in the case of the incinerator stacks, which we're talking about here, it depends quite a bit on what temperature the incinerator operates at. I think the same process is involved; basically, you're using air rather than pure oxygen as the oxidant, the source of combustion. As to what the extent nitrogen oxides are involved here, no work has been done. There are ambient air quality standards for nitrogen dioxide which are exactly the same as those for SO_2, yet to my knowledge I am not aware that any monitoring of this sort has been done in the vicinity of these operations.

DR. S.B. SMITH

Is it difficult to monitor nitrogen oxide in a chimney of any kind? Is it done in steam plants, and can it be done in gas plants?

DR. R. KLEMM

Well, I'm certain it is because in the ambient air quality standards a method, a standard method acceptable to the government, is already detailed. The other obvious,extremely qualitative thing is, at least as we have in Edmonton occasionally, the brown fumes of nitrogen dioxide, but of course we're talking about concentrations that you can't see. Certainly there is a possibility that they do exist , and they could very easily be monitored; after all, what's the sense in establishing your standard if you can't monitor it?

DR. S.B. SMITH

So your answer is that the technology is available; it's done for other chimneys but it isn't done for this industry.

DR. R. KLEMM

That's right. It's not of prime concern here, and it may not be, but it would be nice to see some statement to that effect.

DR. S.B. SMITH

In your written report you mentioned some effects of sulphur or some possibilities of effects on vegetation and domestic stock. Yet there is no reference to the wild ungulates, that is, the common cloven-hoofed mammals -- the deer family, or to birds, or to fishes; and yet the operating plants are in areas which are some of our most heavily populated wildlife areas, the most heavily used for recreational fishing and hunting. Now, is there a reason why you didn't deal with this aspect of it in the report?

DR. R. KLEMM

I would think that this has much to do with the division of responsibilities in pollution control. There have been many cases where there has been environmental damage to streams and rivers, where there's been either an accidental spill or something has been flushed into a stream. This is a case again of a sudden change in the environment for these species, a question of whether this can cause a considerable amount of damage as opposed to continually adding something to the environment. There are regulations, again, in this area, but there's nothing that is particularly enforceable, at least for the water standards for example, except for a particular level of dissolved oxygen. As far as ungulates are concerned, my only knowledge in this area is that the people whom I've interviewed in the Departments of Forestry and Fish and Wildlife seem to consider the industry a relatively clean one from that standpoint.

DR. S.B. SMITH

You just stated that regulations demanded that certain concentrations be measured before these regulations could be enforced. I would like to state for the record that this is not true for Section 33, Subsection 3 of the federal Fisheries Act which has been in use for many years. Any substance, in any concentration deleterious to fishes, is totally prohibited.

DR. R. KLEMM

To explore this a little further, up until the present Clean Water

Act -- I'm not quite sure whether this Clean Water Act is in a finalized form or not -- any prosecutions or attempted prosecutions for continual violation of certain standards of water quality have had to be turned over to the federal regulations for action.

MR. W.A. FLOOK

Dr. Klemm, you mentioned that the efficiency of operation of gas plants varies over a very wide range. I take it you were referring to just those plants that extract sulphur, and the efficiency you were referring to is the efficiency of sulphur recovery.

DR. R. KLEMM

Yes.

MR. W.A. FLOOK

Isn't the efficiency of a gas plant prescribed and regulated by law?

DR. R. KLEMM

The efficiency of the plant, or how much SO_2 has to be vented, is very carefully regulated; it's specified in the regulations initially establishing the setting up of the plant. These are specifications which establish, for example, how much H_2S will be in the inlet on any given day. The amount of sulphur dioxide that you can flare -- the amount of sulphur which can be emitted in any given half-hour period, up the stack -- is also specified, as is the amount emitted in a given day. For example, a plant can exceed a particular half-hour standard once a day, or a number of times a day, provided it doesn't exceed the daily emission of SO_2 or sulphur up the stack.

MR. W.A. FLOOK

But, specifically, the efficiency is prescribed and regulated, the efficiency as based on a material balance of sulphur.

DR. R. KLEMM

On a plant site, by the Conservation Board, yes.

MR. W.A. FLOOK

Now that varies, which means that different efficiencies are ascribed to different plants.

DR. R. KLEMM

That's right.

MR. W.A. FLOOK

On what basis is this determined? Why would one plant be required to operate at a higher efficiency than another?

DR. R. KLEMM

I think this depends to a large measure on the size of the plant. I think if you have a four thousand ton plant operating at 95 percent efficiency, this is still some two hundred tons a day up the chimney; whereas a smaller plant, a fifty-tonner for example, can operate at 85 percent efficiency and not have the environmental impact that the larger does.

MR. W.A. FLOOK

In other words, size is an appropriate basis on which to base the efficiency?

DR. R. KLEMM

I think there are other considerations besides size; the acid gas quality perhaps has some bearing, but if you're asking me whether this efficiency is a reasonable method of regulating industry, I think it's very important. It shouldn't be the only consideration, but certainly this has to do with our long-term effects of sulphur dioxide. It limits the total amount which goes into the atmosphere, and I think that this is also important, as well as ambient air quality.

MR. W.A. FLOOK

I see. But the content of sulphur in the incoming gas is another important factor that would determine the amount of sulphur that is let into the atmosphere at any given efficiency.

DR. R. KLEMM

I think that this is included somehow, but I think plant size is probably the overwhelming factor here.

MR. W.A. FLOOK

Now, this presumably is a device for assuring that ambient air quality standards will be met. And another is the design of the stack.

DR. R. KLEMM

That's right.

MR. W.A. FLOOK

Now, in designing the stack, several parameters are taken into account, aren't they, such as terrain, the height of the stack, the content of sulphur to be dispersed, and so on. A lot of these parameters are meteorological. Is that correct?

DR. R. KLEMM

There's a way of fitting these things in there, yes.

MR. W.A. FLOOK

What I'm trying to get from you is, in designing, in working out the figures for the stack design, is the worst possible combination of meteorological conditions taken into account, or just an average?

DR. R. KLEMM

Well, since they have to apply all the time, I think that all you can do is take an average value, but in the design parameters, for example in areas where there are agriculturally important crops, the calculations require, again as far as I know, two-tenths of a part per million SO_2 as the basis for the calculation, whereas the ambient air quality standard for one hour is three-tenths of a part per million. There's a conservative factor built in here, and I'm sure it's like anything else: you can't build in contingencies that take care of every single instance.

MR. W.A. FLOOK

So there is a possibility . . .

DR. R. KLEMM

Yes, definitely.

DR. W.R. TROST

Would you just, initially, Dr. Klemm, contrast the differences between the flares and the stacks, these so visual manifestations associated with gas plants. What goes on in them, and what comes out of them?

DR. R. KLEMM

Well, I noticed the flares are painted with red and white stripes. They're on the order of 250 to 400 feet high. Flare stacks can have a diameter very much in excess of what you would normally figure for a flare stack. A flare stack is 100 to 150 feet high, and its diameter is in the nature of a few feet. So, I think there must be some metering facility to the flare stack. Again, the flare is used in cases of turn-around, or to clean out a line, or where there's a plant upset of some sort, such as the plant not being able to handle the raw gas coming in; so that hopefully there are some metering facilities on the gas entering the flare stack in order to prevent the emanations from the stack from exceeding the ambient air quality standard. Besides this, there's an entirely separate standard for flare stacks in terms of SO_2. You can flare one part per million for half an hour from a flare stack provided it's a case of an upset or some emergency, but the chemistry which takes place in this flare stack is another thing -- smoky flare stacks have been known for years, and to my mind that is a sign that there's incomplete combustion taking place in these flare stacks. So the supposition that you're converting everything to CO_2 and water in the flare stack is somewhat suspect. It seems to me difficult to monitor these stacks, except with some sort of an off-site mobile monitor. Now a number of plants have used steam injection around the flare stack which eliminates the smoke, but just because you can't see the smoke you still have, potentially, incomplete combustion because the reaction between the steam and the smoke particles is, to my mind, some sort of a water-gas reaction that gives you CO and hydrogen. You're also adding a considerable amount of water to this thing again. Are you making sulphuric acid in this situation? There are a number of regulations which proscribe the operation of flare stacks and incinerator stacks, but because of the technology I think we've been concentrating exclusively on SO_2 as perhaps the pollutant, and I think it's time we progress and look for other possibilities in the stacks.

MR. W.A. FLOOK

Why is it necessary to have two different types of stacks?

DR. R. KLEMM

In the incinerator stack one is disposing of what represents the difference in 100 percent conversion of any sulphur values to elemental sulphur. To disperse this, this can amount to many, many long tons per day, ranging anywhere from a few to hundreds of long tons. In an incinerator stack you have to get this sulphur dioxide high enough up into the atmosphere in order to disperse it widely enough. You, therefore, need a much higher, taller stack, because this is a continuous operation. It is always phased with a total plant inlet. It is through the use of incinerator stacks and their appended technology, that one can keep a check on the efficiency of the plant operation. The flare stacks have controlled combustion. It is possible, if you will, to leak the gas to the flare stack at a controlled rate. This is the reason they are shorter and of smaller diameter.

MR. W.A. FLOOK

In fact you have to take the efficiency of combustion in the flare stack on faith?

DR. R.KLEMM

To a large degree I think that's true. I think that in monitoring the flare stacks again, you have to depend on off-site monitoring, and all you do there is monitor for SO_2 and H_2S. Supposedly everything that goes out that stack is converted to SO_2 and any hydrocarbon which is used to supply the heat value and whatever thermal lift you need is converted to CO_2 and water. How far this occurs is, at the present time, anyone's guess.

DR. W.R. TROST

When you were talking about the different environments which may be affected, you mentioned also, in addition to the community environment and the plant environment, the home environment. Do you want to elaborate a little bit on what you mean by the 'home environment'?

DR. R. KLEMM

What I had in mind was, for example, that in the plant environment you have standards for H_2S and SO_2. For H_2S in the plant, this is a five-day week, eight hours a day. The standards which have been set up in the United States, and to my knowledge they're used here, are ten parts per million H_2S, five parts per million SO_2. So the worker in the plant can tolerate twice as much H_2S as he can SO_2. But now turn around and look at the ambient air quality standards. In the ambient air quality standards it's three-tenths of a part per million for one hour for SO_2, and about 0.03 for H_2S; in other words, the values are completely reversed. What exactly is the rationale for this, I'm not sure, but I would like to bring to your attention the fact that these values are reversed. Now let's turn to the home. The destination of this natural gas determines certain specifications as well. Natural gas that goes to the home cannot have H_2S of a certain concentration. Most of the gas that's delivered to the pipeline has about one grain per hundred standard cubic feet. Here in the province of Alberta the present standard for the home is ten grains per hundred standard cubic feet. So that's one hundred and sixty parts per million per hundred cubic feet of gas. There is a deodorizer added to the gas which allows the gas in the home to be detected at a leak rate of one percent, I believe. So one percent of a hundred and sixty parts per million is 1.6 parts per million H_2S, out of a virtual gas leak in a home. Now, if you contrast that 1.6 parts per million with the ambient air quality standards, it's something like 0.05 or 0.03, at least it's that order of magnitude. You see that there's some contradiction here, between the ambient environment and the home environment specifications.

MR. W.A. FLOOK

The emphasis on stack emissions has been on SO_2. You mentioned that in addition to this there is water, CO_2, heat and other chemicals. Would you like to comment a little on these?

DR. R. KLEMM

Plant efficiency has normally been derived by simply monitoring the raw gas inlet stream to the plant. It has a certain H_2S content. Knowing this H_2S content, how much gas goes into the plant, and then gauging how much elemental sulphur you produce, the difference, SO_2 goes up the stack. The Board can specify the monitoring of other compounds if they so desire. So far, attention has been placed on SO_2 because this is the most important pollutant that we have. What some plants would rather do, and in fact do, is monitor the stream further upstream in the tail gas before any combustion takes place. The reason for this is obvious. You can use this as a control on the plant, because in this tail gas, H_2S and SO_2 should be in the ratio of two to one. They can use this balance or inconsistency in order to run the plant.

A number of plants are looking at the possibility of sending their produced water. This is salt water which contains H_2S, and some plants have up to a hundred gallons to dispose of either downhole or shipped to an empty well. The possibility is being explored of putting that material up the incinerator stack, so that now you have not only SO_2 in the stack but you have salt water going up the stack. The idea is to use the heat value to vaporize the salt water. Now you are not only adding SO_2, but you're combusting the H_2S and the salt water to SO_2. It no longer has anything to do with the plant efficiency. It also contributes a nucleating agent for moisture in sodium chloride.

Elemental sulphur is stored in a pool as a liquid before it is sent to the block piles. This is also a source of H_2S, because H_2S dissolves in the liquid sulphur then escapes through a vent in this pool. One of the ways of removing this pollutant from the plant site is to pass this H_2S into the incinerator stack. In converting this H_2S, you're putting another amount of SO_2 up the stack again which has a nebulous effect on the calculating efficiency.

In pit storage, we have greases and oils, and they are just put out there to weather. There is a possibility some plants have explored the possibility of combusting these products and putting them also in the incinerator stack. Now we're talking not about SO_2 anymore, but about CO_2 and water from the hydrocarbon part of lubricants. Many plants use triaryl phosphates as lubricants, so you're combusting material which contains some other elements besides carbon, hydrogen and sulphur.

MR. W.A. FLOOK

The methods used now for calculating sulphur balances in the plant could stand some improvement?

DR. R. KLEMM

I think the methods of calculating sulphur efficiency are very good now, but I think that this is a separate problem.

DR. S.B. SMITH

I don't see anything on the pollutants, or the possible pollutants from these plants on wild animals, such as fish, wild birds, or wild mammals. Would you care to comment on this? Was there no information available to you, or did you not have enough time, or what was the reason?

DR. R. KLEMM

In the preparation of this report, part of the input came from the

Government Task Force, which represented the various departments of Government which would have an interest in the environmental effects of sulphur gas plants. We had input from Fish and Wildlife people, and Forestry people as well. From that it would seem that there were very few incidents of actual fish kills, notably in the Drywood Creek area in the late sixties. In regard to wild animals, there is really not much information available. As someone pointed out in previous hearings, wild animals can move in and out of the environment. Human beings aren't that free to do so.

PUBLIC HEARINGS
PINCHER CREEK

OCTOBER, 1972

ENVIRONMENT CONSERVATION
AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

OPENING REMARKS

G.R. WALDMAN

Ladies and Gentlemen, my name is Gerry Waldman and I am the Secretary to the Environment Conservation Authority. We would like to welcome you to these hearings on the Environmental Effects of the Operation of Sulphur Extraction Gas Plants in Alberta.

In order to arrange the agenda, it is necessary for us to have registration of all persons intending to present briefs. This we would ask you to do at the registration desk. Ms. Bougie, here, will accept all copies of the briefs and will register you for your presentation. We also have various publications which the Authority has put out and these are available as you enter on the two desks. There is a nominal charge for a few of them. In order that we have a tally of attendance, we would ask you to register at the front desk if you haven't already done so sometime during the hearings.

If it becomes necessary to limit your time later in the day, there is a small timing device which will be placed on the podium. This will be for your own use. This will indicate a green light when you have a minute left and a red when you have run out of time.

For your convenience, I will write the names of the speakers in the order of their appearance on the blackboard here as the day goes by. Now ladies and gentlemen, it is my pleasure to introduce Dr. Walter Trost, Chairman of the Environment Conservation Authority. Dr. Trost.

DR. W.R. TROST

Ladies and Gentlemen, I would like to introduce my two colleagues to you, Dr. Stuart Smith to my right, a Member of the Authority; and Mr. Bill Flook, our Executive Co-Ordinator who is joining us this afternoon and will participate in the questioning that the Authority might address to any submission. As you all know, I believe, this series of public hearings on the Environmental Effects of the Operation of Sulphur Extraction Gas Plants was requested of the Authority by the Honourable Mr. Yurko, Minister of the Environment; and we thereupon worked upon a "Terms of Reference" for the Public Hearings, a copy of which is available outside. I will read the first and the last portion of the "Terms of Reference".

The environmental effects that we are concerned with: "are the effects on the environment of operating sulphur extraction gas plants in Alberta including all effects on materials and on living processes; including beneficial effects, of all developments and manifestations leading to the production of the gas, its treatment and the transportation to and consumption of all products by a customer." Then after several paragraphs; the final paragraph - the objective of this public enquiry is: "through public hearings to enquire into all effects on the environment of the operation of sulphur extraction gas plants in Alberta, and to review all legislation pertaining thereto; and to lay the views presented to the Authority and the Authority's recommendations thereon before the Lieutenant Governor-in-Council through the Minister of the Environment".

After publishing the "Terms of Reference," the Authority also made available to the public a "Prospectus for Public Hearings" which gave some background information. A copy of this is also available outside for those who haven't already got one. In addition the Authority took steps to have prepared, by an independent consultant, a report that we call "the Environmental Effects of the Operation of Sulphur Extraction Gas Plants", and this very well done and very informative publication is also available outside in the anteroom. Dr. Roger Klemm will lead off these Hearings by giving us a summary of his report in a minute.

We are holding hearings throughout Alberta in those parts of the Province that are most closely associated with sour gas; beginning in Pincher Creek on October 2nd, moving to Red Deer on October 5th, to Whitecourt on October 11th, to Calgary on October 16th, and to Edmonton on October 19th where we will hold our last hearing. After the hearings are completed you may be interested to know how we go on once that phase of the work is done.

We will, first of all, prepare what we call the "Proceedings of the Hearings" which will be a publication that contains all of the briefs that were presented at the hearings just as they were presented in written form if they were so presented, or in verbatim oral copy of whatever was said at the hearings including whatever discussions and questioning might occur there. This may well be a lengthly document, and though it is available to the public, we charge roughly what it costs to print, which comes out to be about $4.00 or so. We also prepare a "Summary" of the public hearings which is a concise and objective reduction of what was said. It is about one tenth the size of the "Proceedings" and we make this available to the public at no charge. I think there is room on your card to indicate whether you wish to have these reports sent forward to you as and when they are prepared.

Finally, the "Report and Recommendations" of the Authority itself is put in the hands of the Minister and is released to the public after it has been presented in the Legislature. We therefore report on these hearings in three different publications, all of which are ultimately available to the public.

You will notice that there is a great tangle of wires around. We are recording what we are saying and there is also a T.V. tape being made of these proceedings. These also become records that can be made available to the public through other outlets.

IN THE MATTER OF PUBLIC HEARINGS ON THE ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS IN ALBERTA.

BRIEF BY SARATOGA PROCESSING COMPANY LIMITED TO THE ENVIRONMENT CONSERVATION AUTHORITY.

OCTOBER 2, 1972

Presented by: A. J. Green

1. PURPOSE OF SARATOGA

Saratoga Processing Company Limited (Saratoga) takes the opportunity afforded by the public hearings being conducted by the Environment Conservation Authority of the Province of Alberta, (as set out in the Authority's notice, terms of Reference and Prospectors (Tab 1, 2 and 3), to submit information of a technical nature which, in its view, will be of assistance in the review of legislation pertaining to the operation of sulphur extraction gas plants in the Province of Alberta.

Saratoga intends to confine its brief herein to a discussion of that phase of its corporate activity which is concerned with the processing of natural gas in its Coleman Plant, and more particularly the computation of maximum concentration of pollutants in the atmosphere surrounding the Coleman operation.

2. STATUS OF SARATOGA

Saratoga Processing Company Limited is a provincially incorporated Company in the Province of Alberta, gathering and processing natural gas on a cost of service basis for Westcoast Transmission Company Limited - a federally incorporated company engaged in the business of buying, gathering and processing natural gas in the Northwest Territories, the Yukon and in the provinces of Alberta and British Columbia for resale to customers in Canada and in the United States of America.

3. SARATOGA'S OPERATION

Saratoga owns a natural gas processing plant in the Province of Alberta near Coleman for the processing of natural gas volumes gathered by it from the Savanna Creek Gas Field. The gas obtained from the Savanna Creek Field contains among other constituents, hydrogen sulphide which, after it is removed from the gas stream, is processed in a sulphur plant for the removal of elemental sulphur. Residue gas volumes from the natural gas processing operation are delivered to the pipeline facilities of the Alberta Gas Trunk Line Company Limited, which takes custody of the residue volume for Westcoast Transmission Company Limited. A brief general description of Saratoga's Coleman facilities is presented as Appendix 4, Tab 4.

It is the discharge of sulphur bearing gases from the sulphur recovery operation at Coleman that Saratoga is chiefly concerned with herein.

Attached as Appendix 5, Tab. 5 is a copy of Saratoga's report for January - July, 1972, filed with the Energy Resources Conservation Board in the Province of Alberta, which indicates the gross and net sulphur production and sulphur recovery percentage for the recovery period. Included also are results of performance tests conducted on March 14, 1972, and March 15, 1972. It will be noted that Saratoga's sulphur recovered exceeds the requirements of the Province of Alberta as set out in Exhibit VI under the Tab Marked Exhibits.

4. MONITORING

For a number of years Saratoga has monitored the results of atmospheric emission at its Coleman Plant. Details of the equipment used and the results obtained are annexed hereto as Appendix 6, Tab 6. It should be noted that all monitoring results are within the presently established pollution objectives of the Province of Alberta.

5. SURVEY OF EXISTING STANDARDS

The major air pollutants of natural gas processing are sulphur dioxide and hydrogen sulphide, and in Canada the Federal Government and certain of the provincial Governments have established standards for air quality covering a wide range of pollutants. As well, the Environmental Protection Agency of the United States Government and certain State Governments have published standards. A discussion and comparison of these various standards is annexed as Appendix 7, Tab 7.

6. PREDICTION OF GROUND COVER CONCENTRATIONS OF SO_2 AROUND SULPHUR RECOVERY PLANTS

Currently it is the practice of the Province of Alberta in approving the design of new sulphur plants recovery facilities and the assessment of existing facilities to apply certain mathematical equations to estimate the ground level concentration of sulphur dioxide which will result from a proposed or existing installation.

Saratoga Processing Company Limited is of the opinion that the currently employed equations are unsuited for proposed or existing plants located in areas of extreme topography. This statement it is suggested, is supported by the results of atmospheric monitoring conducted by Companies, such as Saratoga Processing Company Limited. A discussion of the validity of the currently employed equations is presented as Appendix 8, Tab 8.

7. SUMMARY

Saratoga submits that the environmental conservation authority should give consideration in the following when reviewing all legislation pertaining to the operation of sulphur extraction plants in Alberta:

a) The qualitative and quantitative nature of the discharge, the sources and the receiving environment affected, the technical and social tolerance of the areas affected and the assimilative capacity of the environment;

b) The inadequancy of existing theoretical formulae, and therefore, the need for additional research for prediction of dispersion of pollutants in the atmosphere under all conditions of geography, climate and weather;

c) The comparison of actual results of pollution monitoring of atmospheric discharges in present operations with the results forecast by such theoretical calculations;

(d) The possibility of applying control measures to ambient air quality rather than to the quantitative emission of the pollutants at the point of discharge;

(e) The need to continue without interruption the supply of a non-pollutant fuel such as natural gas for use by domestic, commercial and industrial users in the more populated areas of Canada and the United States of America;

(f) The desirability of adopting measures that are compatible with measures adopted and in the use in other jurisdictions having similar problems;

(g) The desirability of reviewing any measures proposed, or in existence prior to their enforcement, with the chemical and petroleum industries to avoid the possible closure of existing plants on the non-development of new plants due to the economics of the measures enforced;

(h) The need to consider the pollution contributed to the environment by all segments of existing or proposed industries.

Dated at Calgary, Alberta, this second day of November, 1972.

All of which is respectfully submitted

SARATOGA PROCESSING COMPANY LIMITED

per: D. P. McDONALD
PRESIDENT

Cont'd..........

All notices and other communications in connection with this submission should be addressed to D. P. McDONALD, Saratoga Processing Company Limited, c/o Petroleum Building, Calgary, Alberta.

WESTCOAST TRANSMISSION COMPANY LIMITED
1333 WEST GEORGIA STREET
VANCOUVER 5, BRITISH COLUMBIA

December 21, 1972

Dr. W.R. Trost
Chairman
The Environment Conservation Authority
9912 - 107th Street
Edmonton, Alberta T5K 1G5

Dear Sir:

Re: Saratoga Processing Co. Ltd. -
Air Shed Study

You will recall I made a presentation to the Environment Conservation Authority hearing on October 2, 1972 at Pincher Creek, Alberta, on behalf of Saratoga Processing Co. Ltd. The brief had reference to studies that Saratoga commissioned relating to the diffusion potential in the air shed surrounding Saratoga processing plant at Coleman, Alberta.

I believe you asked if we could provide the Environment Conservation Authority with a copy of the completed study and accordingly I hereby submit copy of the study entitled "Tetroon Studies of Diffusion Potential in the Air Shed Surrounding the Saratoga Processing Plant" as prepared by Western Research and Development Ltd., Calgary, Alberta.

If I can be of further assistance in this matter please advise.

Yours very truly,

A.J. Green
Manager of Engineering

AJG/bkk
Encl.

QUESTIONING BY THE AUTHORITY

DR. W.R. TROST

Thank you very much Mr. Green. You have given us a very brief summary and a very long attachment, and we appreciate that. There may be some further enlargements that the Authority might wish, particularly in view of the additional material which you have contained herein. Dr. Smith....?

DR. S.B. SMITH

Mr. Chairman, I have two questions for Mr. Green. In B. on page 4 of your summary, you suggest the inadequacy of existing theoretical formulae which has been mentioned, I am sure you are aware, by many engineers and chemists. This would suggest then the need for a very close-knit research effort. Where do you think the best chances are for successful research which would give us adequate formulae - in industry or in government, or in a combination of these, or universities or wherever?

MR. A.J. GREEN

Well, I think, perhaps a combination of both. As far as Saratoga is concerned, and as outlined in our brief, we have embarked upon a program of research to determine the nature of the air currents above and through the valley, and over the mountains away from the plant and Coleman. This research has been carried out by a firm of consultants and the reports, I believe, will be available next month, at which time we would be pleased to forward them to the Authority, as well as the Energy Resources Conservation Board. This is a start in so far as we are concerned, but I am sure that other agencies will wish to do further research in this area as well.

DR. S.B. SMITH

To follow this just a step further, is there any problem in making public the results of such research? Does it give your competitors some advantage, or is t standard in the industry that they should make public their findings?

IR. A.J. GREEN

lo. As far as we are concerned I don't think that there will be any problem in releasing it. We are doing this purely for research purposes and of course the nformation should be made public so everybody will have the benefit of it.

R. S.B. SMITH

hank you. One final question on the next page in F. I am not sure exactly what ou mean by this statement about the desirability of adopting measures that are ompatible with measures in use in other jurisdictions with similar problems. ould you enlarge on that just a little please?

IR. A.J. GREEN

es. I might say that the staff of West Coast Transmission reviewed this problem nd wrote this brief for Saratoga. Of course we are in operation in B.C. as well s in Alberta and we have attended other hearings of this nature. We had made he same statements at other hearings. Of course there are other standards in ffect in Alberta, and we are not trying to imply that you should adopt somebody lse's standards. Very simply, we are hoping that we could be compatible in all reas of our operation. In other words, at the same level of standards we wouldn't e operating at one level in one province and another level in another province.

IR. W.A. FLOOK

Ir. Green, I am rather interested in the beautiful daily material balances of ulphur that you quote in your brief, and I notice that sulphur production per ay is quoted in tons to the second decimal place as is your recovery efficiency. re you quite happy that your measuring devices are, in fact, that accurate?

IR. A.J. GREEN

would have to say, subject to some advice from my advisers, that it would be accurate as to the order of magnitude. I, like you, doubt that it is accurate to the second decimal place. This is simply the way the mathematics came out when we divided one number by another.

MR. W.A. FLOOK

Presumably, your plant, like all others, have large stock piles of sulphur which haven't been cleared for some time.

MR. A.J. GREEN

Yes. However, it wouldn't be as large as others because this is relatively a small plant.

MR. W.A. FLOOK

But in fact, the only way you could be quite sure that these figures were indeed accurate would be to finally liquidate your sulphur pile and realize the amount of sulphur that was indicated in these figues. Until that is done you just trust these figures.

MR. A.J. GREEN

No. I think these figures would be relatively accurate for the daily production records and monthly production records that we have. The areas of inaccuracy may be a method of measuring the sulphur at the outlet of the plant. I don't think that it would be an error much more than 1% or something of that nature, if even that large a number.

DR. W.R. TROST

Mr. Green, many of your recommendations have a similar underlying theme which is that the level of knowledge about many aspects of these processes is not entirely satisfactory, and that we need to improve it and also improve the theoretical base on which you are operating. Is that the general trend?

MR. A.J. GREEN

Yes. Naturally, with respect to the area of topography in which the Coleman plants operate, as you know, it is in a valley surrounded by mountains on both sides which are two to three thousand feet higher than the valley. There is a great deal of atmospheric disturbance in this valley. We feel that the theoretical formulae which are used to calculate ground level concentrations do not take into account features such as these, and therefore when one calculates the theoretical ground level concentration that might be emitted from a plant such as Coleman, it may not correlate with the actual measurements taken in the field.

DR. W.R. TROST

In practice there is apt to be more turbulence and a greater accidental concentration of materials, or something like that, than one would predict from the formulae. Is that what you are saying?

MR. A.J. GREEN

I would think that the formulae just really don't apply in this area. We feel that perhaps the pollutants may be dispersed more rapidly in a wider area than the formulae would indicate. The formulae seem to calculate the ground level concentrations on a conservative basis in this area so that if you measured the actual concentration in the area, you would find it far less than what you would find by calculation.

DR. W.R. TROST

It may be that Saratoga Processing is itself interested in these kinds of calculations; and I am sure that you know, as I do, that there are consultants who believe that they can formulate by setting boundaries and so on, for wind flow and atmospherics that do give some kind of reliability in practice. Do you feel that this is the case. That they can so do?

MR. A.J. GREEN

Well I do feel that I think they do but I think they all use the same formulae that we are speaking of. The ones that we suggest may be inadequate in areas such as this. Of course I can't make that statement for a plant that is located - like most of the plants are located on the prairies in which case the formulae will come much closer to the actual monitoring results.

DR. W.R. TROST

Now, in the more difficult conditions that may be in the foothills and in the mountain passes, what is the nature of the problem that this uncertainty gives rise to?

MR. A.J. GREEN

The only problem is that when one tries to compare the calculated results with measurements actually made on the ground the two generally don't coincide. If one were to be asked to regulate the emission of sulphur dioxide in accordance with calculated values, one would want to advance the argument that, in this case, it does not apply, and one would have to do it by some other means such as material balances in the plant, or something like that.

DR. W.R. TROST

I am trying to find out what is the major difficulty, in controls, in design of the plant, or the design and location of the plant as in this case - or whether the difficulty is that even with the best of controls, it might not be possible to actually get control - whether there is a practical limit to how good the thing can be.

MR. A.J. GREEN

It would certainly enter into the design of the stack because these formulae are used for stack design. That is one factor. I think, in general, it would have to do with control, controls from an authority on the operation of the plant. If one were to control on a calculated value we would suggest that it would be on a conservative side. It would not give recognition to topography and disturbances in the area.

DR. W.R. TROST

Then I think the idea you are expressing may lead into your Recommendation D that the emphasis should be placed on the ambient air quality rather than on the quantitative emission, if I understood that correctly. Do you want to enlarge on that a little bit?

MR. A.J. GREEN

I have reference here to actual measurement in the field at the ground level by monitoring instrumentation.

DR. W.R. TROST

And the values that are found there should be the basis of control right in the plant itself?

MR. A.J. GREEN

Yes. Rather than on theoretical calculation.

DR. W.R. TROST

You understand that these are the two opposed positions about which there is a great deal of discussion. Now do you favour, for particular reasons, ambient air quality control?

MR. A.J. GREEN

Yes.

DR. W.R. TROST

I just wanted to get some elaboration from you also in respect to your Recommendation E in which you say the need to continue without interruption. I thought if you would just elaborate on the kinds of problems that cause you to put that kind of word "without interruption" in.

MR. A.J. GREEN

I think that I put that there as a general statement that we have had at other hearings. We recognize that there is, in Alberta, certainly a different problem than we would have now in other provinces. You have so many plants in Alberta. In other provinces, they may only have one or two. Of course, in that event, if you had to shut down one or two plants for pollution control measures you would have possibly cut off a great deal of the gas. However, I will concede in Alberta that you could regulate the plants without affecting the total supply too much because there are so many plants.

DR. W.R. TROST

Is there any possibility of having a reserve of treated gas that you can call on, or something of that nature?

MR. A.J. GREEN

It is not usual in the gas industry in Canada to have underground reserves or reservoirs, if that is what you are referring to. Usually the reservoirs are put at the other end of a long-distance pipeline to provide a reservoir for surges and such. Pipelines generally in Canada however, do not. I do believe Trans Canada has a gas reservoir near Toronto.

DR. W.R. TROST

Finally, Mr. Green, in your Recommendation G, in which you talk about the problems which might arise, that if regulations are developed, it may make processes uneconomic. Do you want to enlarge a little bit? I am sure that this question will come up again on the significance of the economic factor in this discussion.

MR. A.J. GREEN

Yes. This is just a general reference. Having reference to the Saratoga plant at Coleman, Alberta, we are getting very good recovery right now of our sulphur in the order of 96%. However, the plant was installed in 1961 and designed for 75 million cubic feet per day of raw gas and about 380 tons per day of sulphur. Because of field problems, we are not getting the design volumes out and currently the operation of the plant for the last year or so is down 11 or 12 million cubic feet per day which is one seventh of the design and as a result the operation, to say the least, is marginal from an economic point of view. What we are saying here in general is that if we had to adopt an even more rigid standard in pollution control that would necessitate installation of a lot more equipment. It might necessitate the closure of the plant or something of that nature because it is already a marginal operation. I think it was in that context that we made the remark under Item G.

Brief to the Environment Conservation Authority Regarding the Environmental Aspects of the Operation of Sulphur Extraction Gas Plants in Alberta

Submitted by The Oil, Chemical and Atomic Worker International Union
Presented by: R. C. Basken

This brief is presented by Local 9-835 of the Oil, Chemical and Atomic Workers International Union, Pincher Creek, Alberta. The Local Union is the certified bargaining agent for the employees of the Shell Waterton Gas Plant. This brief is an attempt to express some of the views of the employees with regards to their occupational environment as well as the area environment. The views expressed herein may also be representative of situations which occur in a number of other sour gas plants in the Province of Alberta.

The Union is most appreciative of the opportunity presented by the Environment Conservation Authority to present our views and we wish to assure the Authority that we will assist in any way possible to make sure that these hearings are objective and of assistance to the Alberta Community. We wish to compliment Environment Minister Yurko for his forthright position with regards to the environment and for making these hearings possible.

We underline at the outset of this brief that there is a real and considerable responsibility on the part of the individual operator and tradesman in a gas plant with regard to environmental quality. One action or inaction on the part of one or several employees of a sour gas plant can result in, not only a very real danger to their lives and the lives of their fellow workers, but an extreme danger to the environment outside. It is our desire to co-operate with the authorities and management to ensure that the best possible protection of all receive the highest consideration.

The foregoing then requires co-operation and an understanding that we are working in the interest of each other and not simply making a product or performing a service.

The Shell Waterton gas plant management are deserving of recognition and credit in several areas of its labour-management relationships. Firstly, we compliment the Company and its management representatives for their general attitude towards working men and their general co-operation in most day to day activities. Secondly, in regards to one specific item having to do with occupational and environment health, the Company has gone to some length to prevent mercury contamination, both in its plant and in the surrounding environment. In this latter regard, we specifically compliment the Company on its decision to phase out the use of mercury meters which have in the past resulted in a considerable amount of mercury spillage in the plant, much of which must have found its way into the surrounding environment. We understand that there is probably only one mercury meter remaining in the plant and that no mercury is stored in the plant in any unsafe container.

The local union is of the specific opinion that if we take the necessary steps to clean up the inside of the plant and thus protect the health and safety of the workmen, that this will go a considerable distance towards creating an environment conscious attitude within the plant and a healthier environment outside.

The safety slogan that "a clean plant is a safe plant" has much more than passing significance when it comes to the interior of a sour gas plant.

While we complimented management with regard to their removal of mercury meters from the plant, we must point out that there is still a considerable amount of mercury spillage from breakage of mercury tubes in small instruments. Many of these instruments contain small mercury switches and the mercury is of necessity stored in glass containers in the switch and when broken the mercury falls to the floor to become part of the general environment of the plant. No work has been done to recover floors from the spillage of mercury occuring since the plant was built. The mercury then finds its way into the atmosphere through oxidation and into the river through the sewage system. We do not speak of large quantities of mercury in this area, but with switch breakage frequent, the overall accumulation is worth consideration.

We believe that it should not be possible for any bending of the Pressure Vessels Act in any of its aspects and we specifically point out that the clamping of a crack in a 1,000 pound per square inch sour gas line containing 15% to 17% H_2S should not be permitted and such a crack should be repaired immediately. We also believe that the clamping of a lap in a pipe containing 75 pounds per square inch live steam should also receive immediate attention. We submit that the shutdowns to repair this kind of fault would take something over four hours. It is essential to have a safety first attitude prevalent at all times.

The local union submits that the phenomenon of hydrogen blistering should receive early and immediate attention by all companies where the potential exists and vessel replacement should be carried out to remove the hazard entirely.

The subject of noise levels inside a plant as complex as a sour gas plant is always a difficult problem. The complexity of the problem and the expense of the repair, however, do not justify the continuing and improper condition. We can specifically refer to the sulphur blowers and the suction on the roof of the Shell Waterton gas plant where it is our belief that the design in piping configuration is incorrect. The matter could be repaired but the solution is expensive and difficult. The Company does provide hearing protective equipment. However, we believe that hearing protective equipment is a temporary solution and not a permanent one and we think that this aspect of the inplant environment should receive early attention. The fuel gas makeup valves result in a noise hazard. This again, can be corrected but it is again expensive. The same applies to the 250 pound steam let down procedure used in the Shell gas plant. The noise is so extreme in the high pressure contactor flare that employees have complained of getting dizzy in this vicinity of the plant and any correction would have to result in an almost complete change of the piping system.

The tail gas cleanup which removes some of the combustables may present a difficulty in maintaining the correct temperature at the top of the stack and allow the escape of nitric oxide. We believe that constant monitoring and effective metering systems are not necessarily used or indeed available to protect the public in the immediate vicinity of the plant from this potential hazard. Monitoring of all the normal stacks and effluent drainage systems cannot possibly account for all of the contaminants that are emitted one way or the other into the environment. We specifically point out that in the area near the compressor building called the doghouse eductors, hydrogen sulphide is in the atmosphere almost constantly about fifteen feet above the ground. When you are in the vicinity you automatically put on a mask and the workmen can be protected. The atmosphere, however, receives an unmeasured contaminant.

The sight of raw sulphur with its yellow coloring on the fields and in snowbanks in the immediate vicinity of a sour gas plant is a common sight. It is not uncommon also for the same kind of ripples of sulphur to appear along the side of the railroad tracks where sulphur has been transported in open cars. The dust from the sulphur blocks spreads considerably more rapidly and a greater distance in the Waterton area where the high winds are common and winds of over 100 miles per hour sometimes occur. Most sour gas plants that maintain a sulphur block are involved in land reclamation procedures, but we believe it to be a false economy when the total solution must be to prevent the distribution of the unwanted sulphur in the first place.

Employees at the Shell Waterton gas plant suggest that when gas lines are to be purged an inert substance like nitrogen should be used instead of the sweet gas - sour gas procedure that is currently used. It is probably more convenient to use the system now where sweet gas is pressured into the line for the first checks and sour gas is used on start-up to point out if there is a leak in the line. There is not only a danger to employees who are required on checking the line, but also to the atmosphere should a significant leak or line malfunction occur.

A number of years ago it was not uncommon for an employee in a gas plant to be either ordered or to voluntarily open valves and bleed sour gas to the atmosphere. Significant changes and improvements have taken place and are taking place all the time. Both management and the employees are becoming more conscious of the hazards involved. This places an onerous responsibility upon the employee who must on occasion let his conscience be his guide. He may have to take decisions which will result in production loss rather than pollute the environment. Employees may also, on occasion, have to make reports to the Environment Conservation Authority involving emissions in which metering systems are not designed to record. We believe that employees do indeed have not only a right but a responsibility to request investigations and make reports as they see fit. In the overwhelming majority of cases, an employee would not necessarily have to be concerned about any disciplinary action or reprimand resulting from his making a factual report. However, in the rare instance where a management might contemplate disciplinary action or dismissal or reprimand, we believe that all employees should have full protection by law. The Environment Conservation Authority and the Minister of the Environment can assist in bringing about this reasonable guarantee by requesting and providing Legislative protection wherever necessary.

In conclusion there are two areas where the Union wishes to make suggestions:

(1) The inplant industrial health and safety committees may also act as an Environmental Protection Committee and work with management and the Authority in all matters of environmental concern. We point out that management at the Shell Waterton gas plant have strenuously resisted the involvement of the Union in a safety committee and the matter was turned down by the management in the last negotiations. The matter will be raised again. We believe that our membership can be helpful in the development and carrying out of the health and safety program and indeed an environ-

mental protection program which will be of benefit to the employees, management and the public as a whole.

(2) We believe that a full review of the metering system used to record the environmental emission is essential. We think that a standardized metering system would serve as a benefit to all and would probably reduce the cost to the industry. The calibration of such instruments is an important task and the responsibility for calibration and maintenance should be clearly defined so that the access of the meter is not readily available to anyone with a screwdriver.

Gentlemen, we believe that we have had reasonable co-operation in most aspects of our relationship with the Shell Company at Waterton as it affects these hearings. We look forward to continued and improving co-operation in the future. We thank you for the opportunity to speak to you this afternoon and offer our co-operation in any manner that it might be useful.

All of which is respectfully submitted on behalf of Local 9-835, O.C.A.W.I.U. by R.C. Basken, International Representative.

Local 9-835 Executive

F. Wuth
D. Stuckey
R. Schmidt
T. Scott

Oil, Chemical and Atomic Workers
International Union

100 - 9950 - 107 St.,
Edmonton, Alberta.

INTERNATIONAL REPRESENTATIVE

October 31, 1972

Dr. W.R. Trost, Chairman,
Environment Conservation Authority,
9912 - 107 Street,
Edmonton, Alberta.

Dear Sir:

I am enclosing herewith a copy of a letter which we have written to the Plant Manager of Shell Waterton. I believe the information contained therein is self-explanatory and we ask you to correct your records accordingly.

The confusion in the length of time clamps were applied on lines at the Shell Waterton Gas Plant arose out of the fact that there were two involved; one of which was for a long period of time, probably one year, but the clamp on the sour gas line was in effect for a period of one week. The confusion arose during the question period and does not affect the material substance contained in the brief presented by Local 9-835, O.C.A.W.

Thank you.

Yours very truly,

R.C. Basken/mm

R.C. Basken,
International Rep.

RCB/mm
encl.

c.c. F.N. Wuth.

Oil, Chemical and Atomic Workers
International Union

100 - 9950 - 107 St.,
Edmonton, Alberta.

INTERNATIONAL REPRESENTATIVE

October 31, 1972

Mr. Cliff Paulson,
Plant Manager,
Shell Canada Limited,
Waterton Gas Plant,
Pincher Creek, Alberta.

Dear Sir:

I have been informed by the Local Union executive that one of my statements made at the hearings regarding sulfur extraction plants has left an erroneous impression. It is apparent that I either directly or indirectly made a comment that the clamp on a crack in a thousand pound per square inch sour gas line containing 15% to 17% hydrogen sulphide was left in a temporary condition for a period of up to one year. I am aware that that is not true and that in fact, the temporary clamp was in position for only one week and that then permanent repairs were made.

I apologize for any misunderstanding which may have been brought about by this unintentioned error. I am, by carbon copy of this letter, notifying the Environment Conservation Authority so that their records may be corrected accordingly.

We apologize for any inconvenience that this error may have caused and we wish to assure you that it was not intentional and that we will take every step necessary to ensure that the correct information is made available to those affected.

Yours very truly,

R.C Basken/m

R.C. Basken,
International Rep.

RCB/mm
c.c. Dr. W.R. Trost
F.N. Wuth

opeiu #458

QUESTIONING BY THE AUTHORITY

DR. W.R. TROST

Thank you very much. Dr. Smith?

DR. S.B. SMITH

I have one question, Mr. Basken. You suggested that the efficient operation of the plant was dependent quite heavily on the skill and dedication to the job of the worker in the plant. Are there, across Alberta, co-operative efforts with your Union, not just this Local but with your Union, in dealing with companies and setting up training programs in this regard?

MR. R. BASKEN

We have had for the most part. The companies have sole responsibility for training, although the training programs and the outlines of pay are developed by the collective bargaining agreement. Certainly there are, in most cases, and in Shell Waterton in particular, training programs to provide trained operators that are in control; and that are on shift and are only relieved by a trained operator. These people are not people off the street, they are people that have been working in sour gas plants and have worked in that particular plant. Start-up is something a little bit different where there is no pool of trained operators in the Province of Alberta, therefore start-up procedures require draining from other plants. It may not necessarily be most desirable. For the most part the companies involved use trained people because they also realize that it is an extremely important job that the operator himself performs. The tradesmen, the man that calibrates the instruments, the man that repairs the valves, all of these jobs are extremely important not only to the production of the plant, but the specific environmental operation of it.

DR. S.B. SMITH

In this same regard, what about the efforts of the Alberta Federation of Labour in providing this safety and environmental propaganda to its membership?

MR. R. BASKEN

We have, through the Alberta Federation of Labour, and I happen to be an Executive Officer of that organization, provided some training programs to the Workmen's Compensation Board. There is a training program that is set up entirely for employees of the plant because in the past we have noted that when an employee goes through the training program - I should go back one stage further - earlier than 1970 there were no safety programs available for employees. The only safety programs that were available were available to supervisors and foremen in the plant. We changed that in dealing with the W.C.B. in Alberta to provide, now, the same kind of a safety program sponsored and provided by the W.C.B. for employees, where a group of employees that are on safety committees feel their responsibility for safety sit down and learn basically the same thing that the foreman and the supervisors do. We have however only had about nine courses so far and there has only been one that involved anyone from the gas industry.

DR. S.B. SMITH

What about the area of effect on the natural world of fish, wildlife, plants and this kind of thing. Is there any kind of a series of information booklets or anything available to your union people on the outside effects of gas effluents?

MR. R. BASKEN

Yes, we have a number of publications through the Canadian Labour Congress and through the Alberta Federation of Labour. The most recent one is a booklet entitled "What is Labour's Stake in Environmental Pollution" which is largely distributed in the Province of Alberta.

MR. W.A. FLOOK

Mr. Basken, on page three of your report you imply very strongly that infractions to the regulations attached to the pressure vessels act are occurring. Specifically, you point out that clamping of a crack in a thousand pound per square inch sour gas line containing 15% to 17% H_2S should not be permitted. Are you referring there to a specific incident where this actually was done as a semi-permanent repair?

MR. R. BASKEN

Yes. I am not sure that semi-permanent is the particular or proper wording. I think that it was a temporary thing, but it may go on for a year.

MR. W.A. FLOOK

The point that I am trying to clarify, a bit, in connection with this type of incident is that if a piece of equipment is operating under very high pressure and a rupture occurs then the first aid type of treatment is to block the rupture by some device.

MR. R. BASKEN

That is correct.

MR. W.A. FLOOK

It may be that clamping is the most available and the most appropriate since the alternative is to allow the thing to leak gas.

MR. R. BASKEN

Absolutely. Clamping is probably the only solution in the immediate for the first day, hour, shift, or month, or two months, but certainly not any longer than a very short period of time, depending on the pressure on the line, and the risk. The one that we are referring to here is a situation which has been in existence for almost a year.

MR. W.A. FLOOK

I see, a prolonged period. Thank you.

MR. R. BASKEN

Correct.

DR. W.R. TROST

Mr. Basken, on page four you mentioned hydrogen sulphide in the atmosphere about 15 feet above the ground and apparently in a repetitive way. Do you know where that hydrogen sulphide is?

MR. R. BASKEN

Personally I don't and have no knowledge of the exact location.

DR. W.R. TROST

On page five, Mr. Basken, near the end of the first paragraph, you refer to the rare instance where a management might comtemplate disciplinary action or dismissal or reprimand and then suggest that there be protection against such a contingency. Do you want to elaborate on that somewhat?

MR. R. BASKEN

Yes. We want to elaborate on it because of a number of instances when I have phone calls from individuals. Sometimes they identify themselves or sometimes I can identify them by voice because I know them. This is from plants other than gas plants as well, from plants in the Province of Alberta who want to report that something is wrong in their particular area because they have just done this or that or they have just been ordered to do this or that. That kind of a report comes to me and I am left to check it out.

The employee is in many instances fearful that if he lets his management know he will be in trouble. If he contacts the Authority he will be in trouble, so he contacts me and I am sort of the buffer zone. In many cases this comes about as a result of reporting an accident to the W.C.B. in some plant. I am not, by the way, referring to any specific situation here in the Waterton Gas Plant at this stage at all.

I have had situations that are very pronounced where an individual had received an electrical shock and the individual was in the hospital. He was visited by the plant manager in this small plant. The plant manager advised him to not report it to the W.C.B., that he would receive full pay. If he did report it he could receive only 75% pay. On the particular occasion, the individual, when he got out of the hospital, because he couldn't make a phone call from there, reported it to me. I reported it back and he received Workmen's Compensation and was more than a little unhappy that he only received 75% instead of 100%. Those situations occur.

I have also had calls from individuals who are reporting a contaminant dumped into a river. The report is something that I can't really technically understand but they want to make sure that I get to somebody so that something comes out of it. Then I go to make a report on it and my information is pretty limited. I have no knowledge of who to contact because, on occasion, individuals don't even give me their names. That indicates to us that there is a very severe reluctance on the part of an employee. If there is anything we can do to remove that reluctance it would be indicative of a co-operative effort to include the environment, at least to the knowledge that when something happens, we are going to find out about it immediately and corrective measures can be taken immediately.

DR. W.R. TROST

I think this matter is of some importance. What kind of protection would be needed?

MR. R. BASKEN

Well, probably protection under the W.C.B. Act or under the Alberta Labour Act providing that an employee who makes a report to these authorities that I am speaking of should not be subject in any way to any disciplinary action as a result of his making a factual report. We are certainly not referring to calling the newspaper and spreading that 100 tons of sulphur went into the air when actually it was 100 pounds, but only where an employee is making a satisfactory report.

We also think that it really ties in to a considerable extent with the environmental committee or industrial health and safety committee. We would have the report made directly by the employee to that committee and that committee, we would hope, would be a responsible group of employees in the plant who could check it out for its technical validity in the first place before any report was made.

The first report then should be to the management of the company so that the logical stages could occur. As I have pointed out, however, in the brief, we have not always had success in getting the management to recognize industrial health and safety committees, let alone environmental protection committees.

DR. W.R. TROST

And the industrial health and safety committee is a committee in the Union?

MR. R. BASKEN

This is a committee of employees within the plant that are designated as the "safety committee" or the "safety and health committee" that meet the management in accordance with preconceived ideas of times of meetings and subjects of meetings. They would be appointed by the local union executive at local union meetings from people who are interested in safety. What we have had in occupational health and safety committees across Canada, and nearly across North America for the most part, have been health and safety committees that have been consisting of three people from management and three people from the union or from among the em-

ployees if there is no union in the plant. What the management does is to appoint one person each month to replace a member of the committee and in that way give everybody a shot at being part of the safety committee.
We found that to be very unsatisfactory because all it does is create a situation where safety is everybody's responsibility but nobody's responsibility. Maybe the individual has had some training in health and safety but in the overwhelming number of cases he has had absolutely no training and doesn't know what his responsibility is. He simply listens to a report on the last accident from the management committee who have been involved in investigation. The employee wouldn't have even necessarily been involved in any investigation of an accident that occurred.

DR. W.R. TROST

Has there been a history of health or safety events? Is there a problem?

MR. R. BASKEN

There is a history of employees being overcome by hydrogen sulphide. That history is being documented by the W.C.B. The Shell Company in this particular area does something that some other companies don't, but in this particular case, if an employee is overcome by hydrogen sulphide, no matter how minimal he is overcome, he is always taken to the hospital or has a doctor check him. In some plants, this isn't necessarily the case. I don't know whether there is a record readily available in all of those kinds of cases. If an employee just gets knocked to his knees for a few seconds and he is checked by a doctor and found completely healthy, we know of no record that we have, at least in that regard. The company definitely will have one and the W.C.B. may have.
These accidents are reportable to the W.C.B., but are not necessarily reported because they occur with relative frequency, I suppose, and there are no severe after-affects. There is no real desire on the part of the employee to get it in record. He just does not bother.

DR. W.R. TROST

You paid specific attention to the noise problem. I want to make this a general question to do with industrial health. Sometimes there are regulations or precautions that have been worked out. Sometimes those regulations or precautions are not followed for some reason or another and sometimes it is an accident that creates the difficulty. In this particular case of the noise, for example, do the men wear protectors?

MR. R. BASKEN

Hearing protection is available and it is my understanding that the overwhelming majority of them do use them, I am sure that they all do. As to whether it is completely effective or not, I have no knowledge of the technical validity of the equipment; but I assume that it is pretty top notch equipment.

DR. W.R. TROST

In a way then I am returning to Dr. Smith's original question regarding the advantage of training programs in respect of environmental protection and safety matters. Are these not yet initiated as fully as you might like them to be?

MR. R. BASKEN

Absolutely not. Particularly in some areas where there is no safety committee or no recognition nor involvement by the employees in the plant. I think that management is missing something. The authorities are missing something when they don't get involvement in creating a consciousness about the work place. The environment is also involved in this whole situation. We try to use the theme in our Union that if you clean up the inside of the plant you create the consciousness that is necessary to keep the outside clean as well. It is probably more important to keep the outside clean than to try to clean it up after it is contaminated.

DR. W.R. TROST

Your basic suggestion is that this is a matter that Labour and Management can handle co-operatively.

MR. R. BASKEN

In that particular area, yes. In the area of noise and things like that where some expertise is required we have to reply on the Board of Industrial Health of the Province of Alberta and they are just absolutely notoriously short of staff. There is only one person responsible for the whole province in checking the noise regulations. Certainly, companies in many areas are making significant strides to improve the sound problems that they do have and I get a number of reports every day from plants who have had tests made and are making corrective procedures; but certainly the Board of Industrial Health is so short staffed that there is really not any hope of that particular Board under its present structure providing an adequate service to the Province of Alberta.

DR. W.R. TROST

Thank you very much Mr. Basken. Ladies and Gentlemen, I am told that coffee is waiting just outside in the hall so we can now have a break for fifteen minutes.

SHELL CANADA LIMITED

SUBMISSION
to the
ENVIRONMENT CONSERVATION AUTHORITY
Inquiry into
THE ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS

AN ENVIRONMENTAL ASSESSMENT
of the
SHELL WATERTON GAS PLANT

Prepared By

SHELL CANADA LIMITED
EXPLORATION AND PRODUCTION DEPARTMENT

Presented By
R. G. Naden

October 2, 1972

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1. INTRODUCTION

Pursuant to a request by the Honourable William J. Yurko, Minister of the Environment, the Environment Conservation Authority is conducting Public Hearings on the Environmental Effects of the Operation of Sulphur Extraction Gas Plants in Alberta. Shell, one of the major gas producers in the Province, has a vital interest in the matters to be discussed at these Hearings and therefore submits this Brief as an environmental assessment of the Waterton plant operation.

Contemporary society requires an ever-increasing supply of energy to sustain the continuous improvement in living standards that has become a part of its normal expectations. At the same time, society has made it clear that it wants the quality of life made possible by a clean environment. Shell believes both these goals can be achieved if industry and the public generally — are willing to bear their appropriate share of the responsibility and the cost. Shell recognizes and believes that its resources must be managed in a manner compatible with the community in which it operates and therefore is prepared to continue to work together with all concerned.

The bringing about of a proper and stable balance between the need for energy and the desire for environmental well-being can be accomplished by thoughtfully conceived and designed control measures. The approach should be a rational investigation of the problem, development of suitable technology, and an understanding of the total cost/benefit effect of the desired improvement. For example, interim regulations that require installation of expensive equipment which could be quickly outmoded by new regulations should be avoided. One should strive for firm but reasonable deadlines for compliance with environmental guidelines so that industry will not be forced to use stop-gap measures involving equipment and processes tending to early obsolescence. Intelligent planning and the mobilization of cooperative action now in progress should enable all sectors of our society to work out sound, long lasting solutions to their mutual problems.

This brief includes information on the operation and environmental control of Shell's Waterton gas plant and field facilities relative to existing conservation and pollution abatement regulations. In addition, current environmental projects and their objectives are reviewed.

2. SUMMARY

Sulphur extraction plants and their rapid growth in Alberta have become a matter of increasing environmental concern to industry, government and the community. Oxides of sulphur released to the atmosphere as waste from the sulphur recovery process are the principal subject of this concern.

Many qualified people have investigated the effects of oxides of sulphur on the environment and their findings have resulted in the establishment of air quality criteria. In Alberta, the Department of the Environment ambient air quality standards and the Energy Resources Conservation Board (E.R.C.B.) regulations are comparable to the Federal (The Clean Air Act) ambient air quality objectives and the recommended criteria developed by the U.S. Department of Health, Education and Welfare. In Shell's opinion the present Alberta regulations have a considerable margin of safety for recognized environmental considerations.

The existing E.R.C.B. regulations combined with effective control demand lower ground level concentrations than those required by the existing air quality criteria for Alberta. The present monitoring and reporting procedures are intended to ensure that the plant operates with maximum regard to environmental emission control. The continuous stack emissions monitoring system provides an effective measuring system for sulphur stack emissions and also the data necessary to properly control sulphur plant operations. In addition, ground level concentration data, continuously measured downwind of the plant and telemetered back to the control room, enable the plant to conduct its operation in a controlled manner under varying meteorological conditions.

The water quality approval for the Waterton plant combined with the surface water quality criteria for Alberta are designed to provide a plant waste water effluent that is adequately treated before entering the neighbouring watercourse. The waste water treating system and effluent analytical testing programs at the plant comply with the monitoring requirements of the Department of the Environment. The combination of a dynamic fish bio-assay system and the existing regulations provide an effluent quality that is safe to livestock and human beings, capable of supporting fresh water organisms and aesthetically pleasing.

Despite extensive research into monitoring systems and development of improved process technology, gas and sulphur plants occasionally experience equipment failures and process upsets. Some of these are due to the newness of the technology involved. The Waterton plant is no exception to this. Where operations under these conditions exceed or might exceed quality criteria limits, it is our operating policy to reduce plant throughput. Accordingly, while we do not claim a perfect operating record, we have not continued any operation which was known or suspected to create an environmental hazard.

Shell is concerned with the environmental effects of the Waterton operation on the local ranching and farming community. Our continuing objective is to improve our performance with the development of pollution abatement technology and its practical application. To this end, Shell is actively engaged in several programs to further reduce the emission of environmental contaminants. These programs are intended to identify the sources and effect of the contaminants, and to provide data on which to base positive corrective action.

Striving to better the environmental objectives of the Shell plant has and will continue to involve major capital and operating expenditures. Our environmental programs and projects utilize over 75 percent of our total technical staff effort at the plant.

As an important part of its corporate philosophy Shell strives to be a good neighbour and our programs with regard to pollution abatement demonstrate our determination to minimize the effect of the Waterton plant operation on the natural environment.

3. SHELL WATERTON GAS PROCESSING OPERATION

3.1 DEVELOPMENT OF THE SHELL WATERTON FIELD AND PLANT

3.1.1 Waterton Field

The Waterton field is situated 120 miles south of Calgary and approximately 12 miles southwest of Pincher Creek.

Seismic operations had outlined the essential elements of the field by late 1955 and in 1957 the Shell Waterton No. 1 discovery well was drilled. Because of the complex structure of the Waterton field, reservoir data were accumulated for several years before the total reserves were determined. This led to a stage wise development of plant capacity and associated gas gathering facilities.

The present field development and gas gathering system is shown in Figure 1.

3.1.2 Waterton Plant Complex

The original scheme for the processing and disposal of the gas produced from the Waterton field was approved by the Alberta Oil and Gas Conservation Board on March 30, 1961.

Approval for the proposal was also received from the Provincial Board of Health on March 22, 1961 specifying air and water quality standards. The Government approvals in addition to stipulating waste water quality standards, required a sulphur plant recovery efficiency of 94.5 percent, a minimum stack top temperature of 1000°F, an average hourly ground level sulphur dioxide concentration of less than 0.22 ppm and an air quality monitoring system consisting of two mobile trailers and 30 sulphation exposure cylinders located in the plant vicinity.

Gas sales began in January, 1962 to Alberta and Southern Gas Company under a contract calling for a peak gas sales rate of 120 MMCF/D.

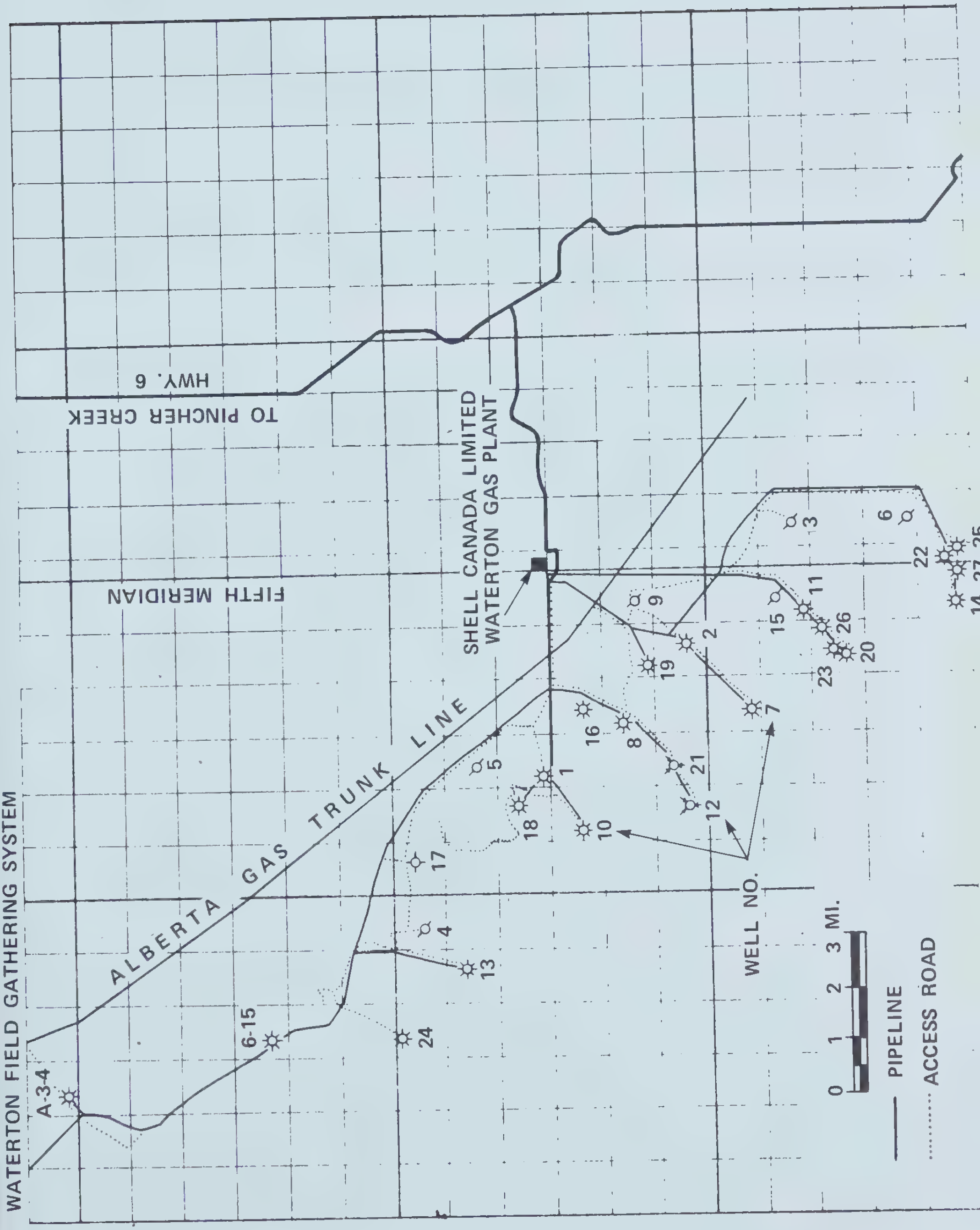
On May 11, 1966, following indications of greater reserves, Shell requested approval for the expansion of the Waterton plant to include facilities for recovery of additional sales gas, hydrocarbon liquids (pentanes-plus) and liquified petroleum gases (propane and butane). The expansion was approved by the Oil and Gas Conservation Board on July 7, 1966 (Approval 866).

Department of Health approvals for this project were received on August 15, 1966 for air quality and June 29, 1966 for water quality. Pertinent in these approvals were amendments to allowable pollutant emissions. The sulphur plant recovery efficiency was increased to 96.0 percent, the required number of stack surveys was set at 4 per year and one mobile trailer was to operate continuously.

Gas delivery to Alberta and Southern began in December, 1967 under a contract calling for a peak gas sales rate of 168.8 MMCF/D.

Following indication of still greater reserves, Shell requested, on February 28, 1969, permission to construct a new plant to increase the peak sales gas capacity of the Waterton plant to 311 MMCF/D and to increase pentanes-plus, propane, butane and sulphur production. Construction of the new facilities followed approvals by the Oil and Gas Conservation Board and the Department of Health in early 1969. Additional sales gas delivery began in December, 1971 to Alberta and Southern.

Figure 1


WATERTON FIELD GATHERING SYSTEM
ALBERTA GAS TRUNK LINE
HWY. 6
TO PINCHER CREEK
FIFTH MERIDIAN
SHELL CANADA LIMITED
WATERTON GAS PLANT
WELL NO.
A-3-4
6-15
24
13
4
17
18
1
10
5
16
8
21
12
19
9
2
7
3
15
11
26
23
20
6
22
14
0
1
2
3 MI.
PIPELINE
ACCESS ROAD

The present facilities are shown in Figure 2 with the No. 2 plant located to the west (right) of the No. 1 plant. The expanded complex currently employs approximately 150 company and 60 non-company personnel resident in the area and has an annual payroll of nearly $3. million.

Throughout the development of the Waterton field and plant complex, applications to, and approvals from various government regulatory groups were made and obtained. They are summarized in Table 2.

3.2 PROCESS DESCRIPTION

3.2.1 Plant Purpose

The purpose of the Waterton gas plant is to process raw natural gas into saleable natural gas and co-products in the most efficient and economic manner possible within the limits of existing conservation and environmental regulations.

3.2.2 Gas Analyses and Plant Products

The Waterton plant is designed to process residue gas at a rate of 311 MMCF/D together with propane, butane, pentanes-plus and sulphur as co-products. The source and quantity of these products is summarized in Table 1.

Table 1

WATERTON PRODUCT SOURCE AND QUANTITY

COMPONENT	% BY VOLUME IN RAW GAS	FINAL PRODUCT	QUANTITY
Methane	65 - 70	Sales Gas	311 MMCF/D
Ethane	3 - 4		
Propane	1 - 2	Liquified Petroleum Gases	2700 BBL/D
Butane	1 - 2		
Pentanes-plus	5 - 6	Gasoline Condensate	31,900 BBL/D
Hydrogen Sulphide	15 - 20	Elemental Sulphur	2,930 LT/D
Carbon Dioxide	2 - 4	Waste Gas Disposed to Incinerator	
Produced Water of Condensation		Reinjected to underground formation	150 BBL/D

3.2.3 Processing Operation

Although the detailed process differs at each plant, the same general unit operations are required to process sour, wet natural gas into saleable products. A simplified schematic drawing of the major processes at the Waterton Plant is presented in Figure 3.

Gas produced from wells in the field (1) is delivered to the plant inlet separator (2) where the produced water and liquid hydrocarbons are separated from the raw gas. The produced water is drawn off the bottom of the liquid and treated in a sour water stripper (3) to remove hydrogen sulphide and other dissolved gases. The treated produced water is stored in tanks (4) and then reinjected into an underground formation (5). The liquid hydrocarbons are directed to a condensate stabilizer system (6) where the more volatile hydrocarbons together with the hydrogen sulphide are removed. The stabilized pentanes-plus (similar to motor gasoline) is stored in tanks (7) until delivered by pipe line to a refinery. The volatile hydrocarbons are routed to the low pressure Sulfinol contactor (8) to remove hydrogen sulphide and then sent to the LPG unit (9) where they are separated into propane, butane and residual pentanes-plus. The propane and butane are stored separately (10) until delivered to markets by rail, tank truck or pipeline.

Figure 2

WATERTON PLANT COMPLEX

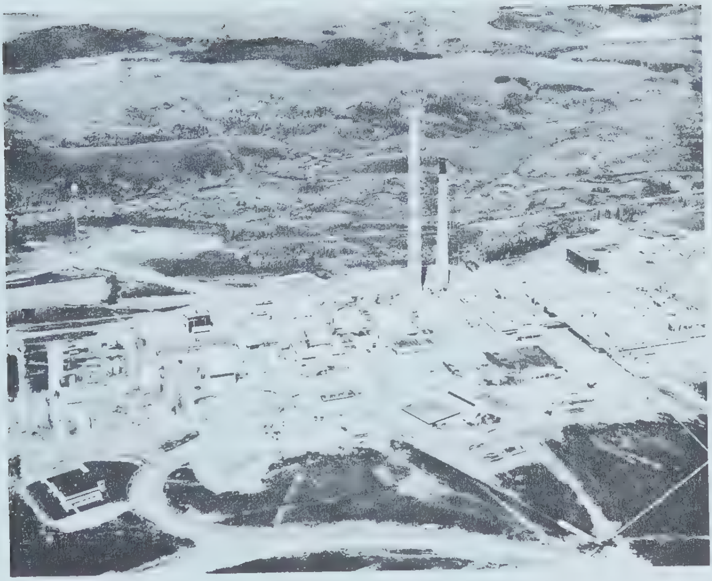


Table 2

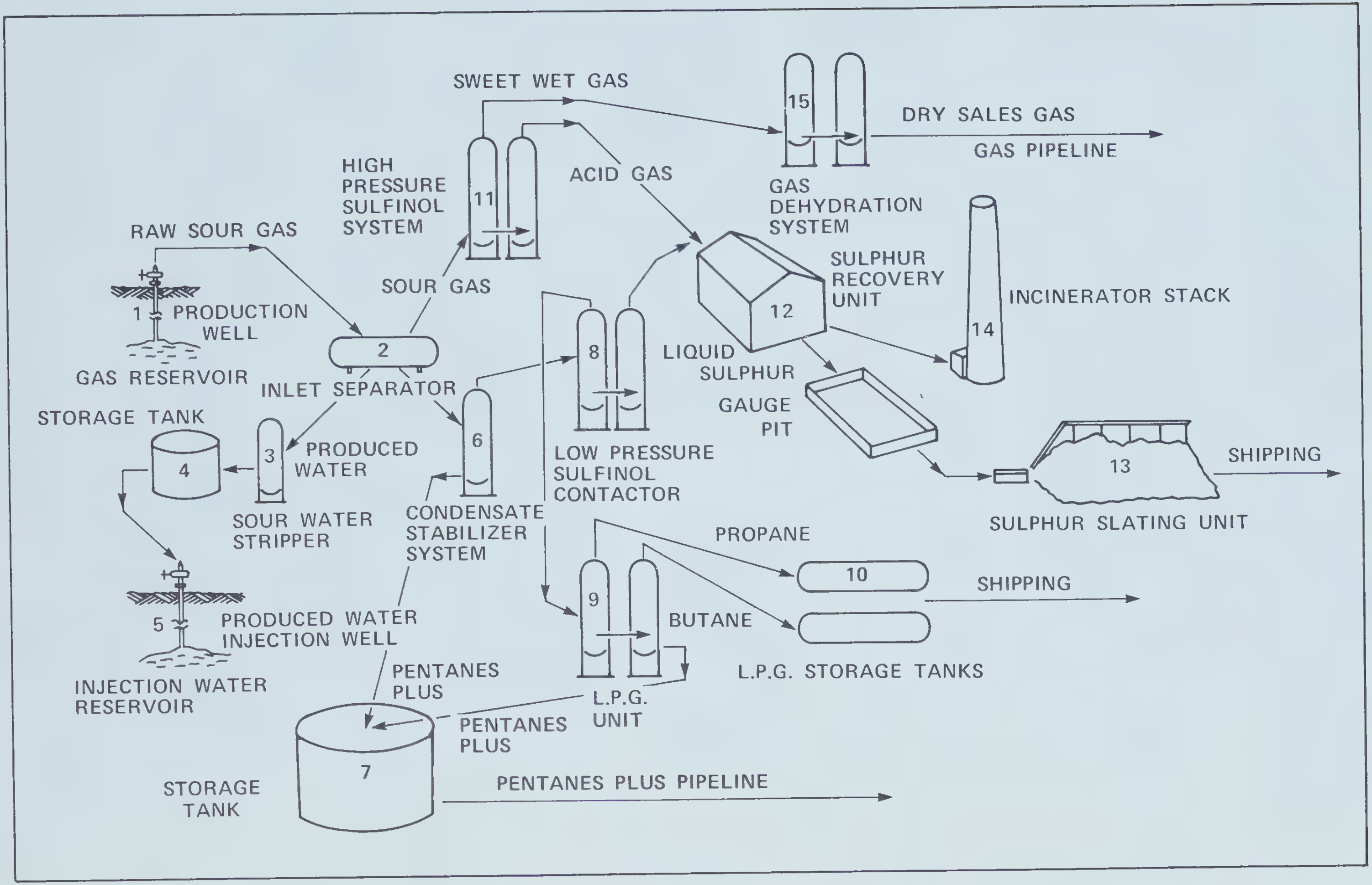
CHRONOLOGICAL HISTORY OF WATERTON PLANT APPROVALS

APPROVAL TITLE AND NUMBER	AUTHORITY	DATE OF APPROVAL	OBJECTIVES
Air and Water Pollution	Department of Public Health	March 22, 1961	Control of air and water effluents from original plant
Approval 410	Oil and Gas Conservation Board	March 30, 1961	Processing and disposal of gas from original plant
Interim Licence 4152	Alberta Water Resources Office	May 30, 1961	Utilization of water from Drywood Creek
Final Water Pollution Approval 31-S-155	Department of Health	June 29, 1966	Control of water effluents from expanded plant
Approval 866	Oil and Gas Conservation Board	July 7, 1966	Processing and disposal of gas from expanded plant
Final Air Pollution Approval 334-P-514	Department of Health	August 15, 1966	Control of air effluents from expanded plant
Approval 1161	Oil and Gas Conservation Board	April 11, 1969	Processing and disposal of gas for Waterton 1 and 2 plants
Provisional Air Pollution Approval 1055-P-54	Department of Health	June 6, 1969	Control of air effluents from Waterton 1 and 2 plants
Final Water Pollution Approval 108-S-1969	Department of Health	November 28, 1969	Ammendment to Approval 31-S-155
Final Water Pollution Approval 100-S-1969*	Department of Health	February 9, 1970	Control of water effluents from Waterton 1 and 2 plants
Final Air Pollution Approval 1116-P-514	Department of Health	February 17, 1970	Control of air effluents from Waterton 1 and 2 plants
Interim Licence 6792*	Alberta Water Resources Office	September 1, 1970	Utilization of water from Drywood Creek
Approval 1394 *	Oil and Gas Conservation Board	November 23, 1970	Processing and disposal of gas for Waterton 1 and 2 plants. Consolidation of previous approvals 1161 and 1116-P-514
Approval 1394A*	Energy Resources Conservation Board	May 30, 1972	Amendment to Approval 1394

*Approvals under which Waterton Plant is currently operating

Figure 3

WATERTON PLANT PROCESS FLOW DIAGRAM



The sour gas from the inlet separator flows to the high pressure Sulfinol system (11). Here hydrogen sulphide and carbon dioxide, referred to as acid gases, are removed. These acid gases together with the acid gases from the low pressure Sulfinol system flow to the sulphur recovery unit (12). Elemental sulphur is recovered and delivered to the sulphur slating unit (13) in liquid form. The sulphur solidifies in thin sheets and is stored as broken slates until shipped to markets by rail. Unrecovered sulphur is incinerated to sulphur dioxide and emitted to atmosphere at 1000°F through a 500 foot disposal stack (14).

The sweetened gas from the Sulfinol system is sent to the dehydration system (15) for removal of water vapour before entering a transmission pipeline as saleable natural gas.

4. CONTROLLING THE IMPACT OF WATERTON PLANT OPERATIONS ON THE ENVIRONMENT

4.1 MEASUREMENT AND CONTROL OF ENVIRONMENTAL CONTAMINANTS

4.1.1 Sulphur Recovery Unit and Incinerator Stack

4.1.1.1 Claus Recovery Process

Many factors enter into the efficiency of a sulphur plant including condition and type of catalyst, nature of acid gas feed, size of reaction furnaces, maintenance of optimum process variables such as temperature, pressure, hydrogen sulphide/sulphur dioxide ratio control, and overall plant reliability. Upset conditions in many parts of the plant process can have a direct effect on the operation of the sulphur plant. The practical limit of recovery for a 3 or 4 stage Claus plant is approximately 97 percent. This requires steady operation and the optimization of all the variables mentioned earlier.

The major source of emissions from the sulphur plant is the unrecovered sulphur and its compounds. These wastes are burned in the incinerator so that they are in the form of sulphur dioxide when emitted to the atmosphere through the 500 foot disposal stack. The amount of sulphur dioxide emitted is directly related to the recovery efficiency of the plant and any upset in the sulphur plant or upstream processing units can result in less than optimum conditions with consequent increased sulphur dioxide emissions.

4.1.1.2 Continuous Stack Emission and Temperature Monitoring Systems

A continuous stack emission monitoring system (CSEM) measures the quantity of sulphur dioxide emitted to the atmosphere on a continuous basis. It presently consists of an infra-red detection system for measuring the percent sulphur in the flue gas and a pitot system in the stack for flow rate measurement. An integrator system combines the data to produce a continuous recording of sulphur dioxide emissions. In addition, thermocouples in the stack continuously monitor the stack top temperature and a record of the results is printed out in the plant control room.

E.R.C.B. Approval 1394 (Table 3) stipulates the maximum sulphur dioxide emissions and the minimum stack top temperature allowed. Continuous monitoring and recording of stack emissions provides one of the key performance controls to maximum sulphur recovery. The effectiveness of the half hour sulphur dioxide emission regulation as a control only came about following the development by industry of a reliable and accurate measurement system for stack emissions. Continuous measurement of stack top temperature assures adequate thermal lift for maximum dispersion.

Daily gas chromatograph analyses are conducted by the Waterton laboratory on the sulphur plant process streams. These analyses are used to provide data for the sulphur plant balance report and to check the accuracy of the CSEM system. Wet chemical tests on the stack effluent, velocity profile studies and a helium dilution-mass spectrograph test have also been employed to check and calibrate the CSEM system.

4.1.1.3 Daily Sulphur Balance Report

The E.R.C.B. requires that a daily sulphur balance to identify the source and disposition of all sulphur compounds be calculated around the entire plant. All the sulphur entering the plant must be accounted for either as sulphur production, sulphur dioxide up the stack, residual hydrogen sulphide in the pentanes-plus or as flared sulphur dioxide.

Table 3

ENERGY RESOURCES CONSERVATION BOARD APPROVAL 1394 AND 1394.A

ERCB Approval No. 1394 and 1394A replace previous Board approvals as well as Board of Health approvals. The main points in the Approval are:

1.	Plant Feedstock Rate (MMCF/D)	473
2.	Plant Inlet H_2S Rate (MMCF/D)	82.40
3.	SO_2 Emission (LT/D)	248
4.	Sulphur Recovery Efficiency	96.0%
5.	Minimum Stack Exit Temperature	1000°F
6.	No. of Stack Surveys Required	6/yr
7.	Ambient Air Quality Trailers	Five
	No. of months	12 months
	Trailer Monitoring Limits SO_2	0.20 ppm half hour average
8.	Annual Ratio of Flared Gas to Plant Inlet Gas	Less than 0.5%
9.	True Vapor Pressure Pentanes-plus	12.0 psia maximum
10.	Minimum No. of Sulphation Exposure Stations	30
11.	Dilution gas must be used when flaring sour gas	

The sulphur plant balance provides another check on the accuracy of the CSEM and serves as a good accounting measure for the total plant operation.

4.1.1.4 Stack Surveys

The Waterton plant is required by E.R.C.B. Approval 1394 to conduct six stack surveys per year. These surveys are conducted by contract specialists. Government stack surveys can be conducted at any time.

In order to provide more comprehensive monitoring and CSEM checks, the Waterton plant has been averaging 20 stack surveys a year at an approximate cost of $1,000 per survey.

4.1.2 Plant and Field Flare Systems

4.1.2.1 Purpose of Flare Systems

The plant and field flare systems are required by safety, conservation and environmental regulations to provide a rapid and safe method of depressuring and shutting down the plant or field facilities in the event of a critical process upset or mechanical failure of equipment. The flares are kept burning with a pilot flame of natural gas to ensure that any gases emitted from vessels for whatever reason are combusted to final products of carbon dioxide, water vapor and sulphur dioxide.

4.1.2.2 Measurement of Flared Gas

All flaring is measured either directly or from material balances around process units based on flows at the time of flaring. The amount of gas flared, the percentage of hydrogen sulphide present and the amount of sulphur dioxide emitted is reported to the E.R.C.B. in the sulphur balance report together with an explanation of the causes and the remedial action taken.

4.1.2.3 Sweet Gas Dilution

To minimize the effects of the pollutants and to ensure their complete combustion, sweet fuel gas is added when flaring sour gas streams. The quantity of the fuel gas added is specified in E.R.C.B. Approval 1394.

4.1.2.4 Smokeless Devices

Systems have been installed on appropriate plant flares where smoke may be a problem to permit the constant injection of steam. During periods of flaring the steam promotes mixing, improves combustion and reduces smoke.

4.1.2.5 Maximum Flared Gas Allowables

The Board is notified immediately in the event of all significant emergency flaring and approval must be obtained from the Board for any planned flaring necessitated by the particular nature of a field or plant problem.

Flaring is also subject to the restrictions imposed by ground level regulations and therefore, no operation is allowed to continue which requires extensive flaring. The annual volume of flared gas cannot exceed 0.5% of the inlet raw gas to the plant.

Restrictions on flaring in the field are similar to those in the plant. As in the plant, flaring must be done through flare stacks and the quantities must be measured.

4.1.3 Ground Level Concentrations

4.1.3.1 Air Quality Monitoring Trailers

The Sulphur plant operation is also monitored indirectly by continuous ground level concentration measurements. The Waterton plant system consists of five trailers each equipped with sulphur dioxide and hydrogen sulphide analyzers and wind velocity and direction instruments. The sulphur dioxide results are telemetered to the plant control room and printed out by recorders. If, at any time sulphur dioxide ground level concentrations approach the allowable limits of 0.2 ppm, the plant must take immediate action. The initial action is to locate any possible plant problem which may be causing the increased readings. Failing this, the stack top temperature is raised for better thermal lift and atmospheric mixing. If this action is not sufficient sulphur plant operations are cut back even though total sulphur dioxide emission levels are not being exceeded.

The ground level monitoring system attempts to ensure that even under adverse meteorological conditions which restrict thermal rise and atmospheric mixing, air quality control is being maintained at the Waterton plant. The theoretical equations which are used for determining the stack height necessary to meet the required ground level concentrations, make only minor allowances for atmospheric conditions. The ground level monitoring system however, provides a continuous sulphur dioxide measuring system for all possible atmospheric conditions.

The success of the ground level monitoring system is also predicated on an accurate measurement and reporting system. The requirement for accuracy is covered by the Department of Environment air monitoring directives. The sulphur dioxide analyzers are calibrated monthly by Waterton laboratory personnel and checked by contract specialists. The calibration curves, methods of calibration and strip charts of the calibration must be submitted monthly to the Department of the Environment together with instrument data sheets and a complete report on the instrument readings. These monitoring data include hourly wind speed and direction, hourly averages for sulphur dioxide and hydrogen sulphide, and all peak readings including their magnitude and duration. Explanations of occurrence and remedial action must accompany any readings which exceed permitted ground level concentrations. If ambient air quality standards are exceeded, the Department of the Environment is notified by phone or telex with a follow-up letter within a week.

4.1.3.2 Sulphation Exposure Stations

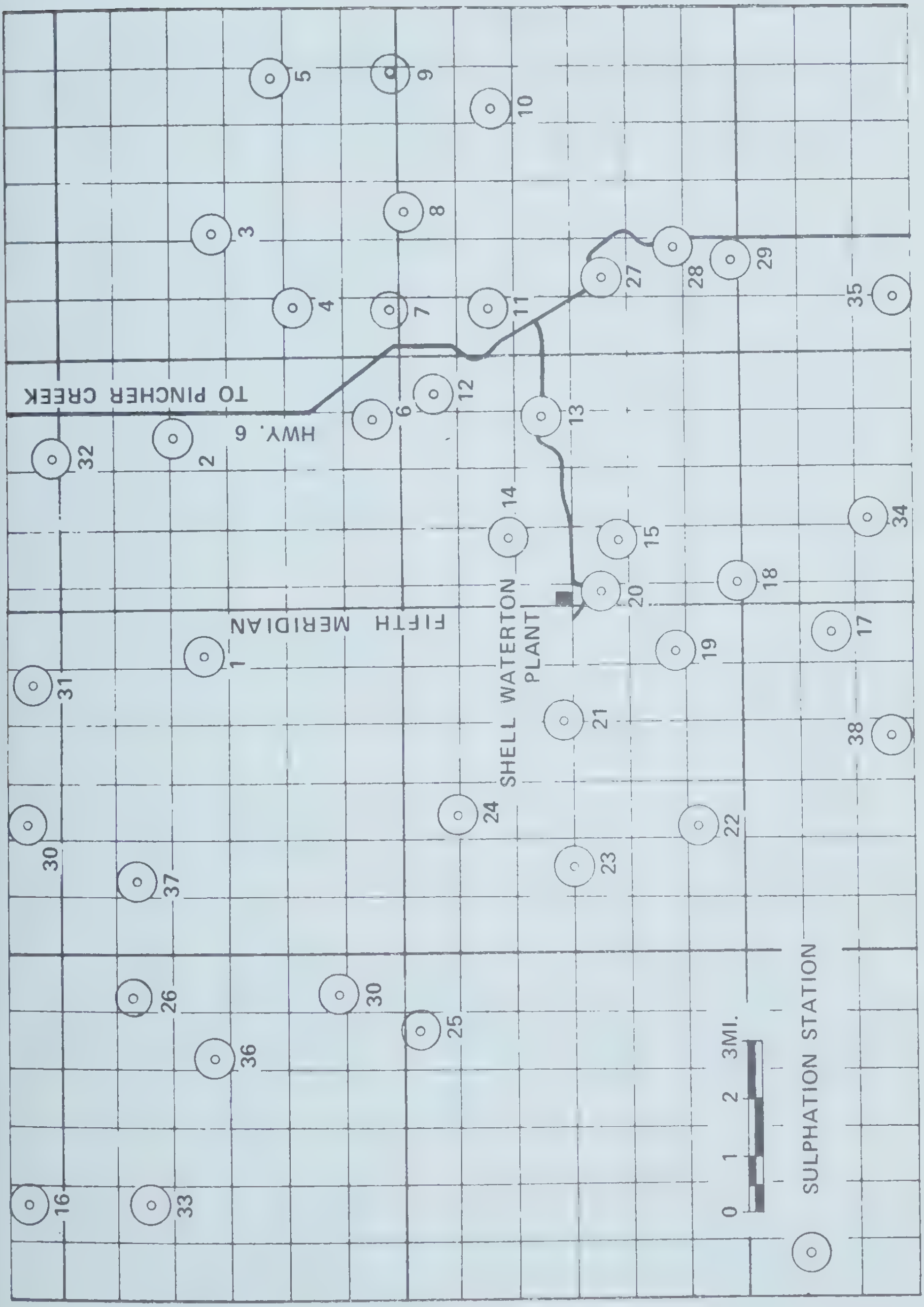
Another monitoring and control system which measures the performance of the sulphur plant as well as the total plant is the sulphation exposure cylinder system. Figure 4 shows the locations of the 39 stations in the plant area. The sulphation cylinders are exposed for a month and then analyzed by a contract laboratory. Sulphation results are sent to the Department of the Environment monthly.

Sulphation results provide good historical information on the effect of sulphur extraction plants in the area. Although the results cannot be attributed to a single high emission or to a continuous low average emission without additional information, they show long term average effects and increasing or decreasing emission trends.

4.1.4 Spill Contingency Plan

A spill contingency plan for the Waterton plant and field was developed by Shell in accordance with E.R.C.B. requirements. The plan, filed with the E.R.C.B., provides a procedure for handling and reporting any emergency which may occur within the plant or the field.

Figure 4



WATERTON SULPHATION STATION LOCATIONS

4.1.5 Sulphur Pouring, Loading and Transportation

4.1.5.1 Sulphur Slating Operation

The objective of the liquid sulphur slating operation is to minimize dusting, a condition which was prevalent when sulphur was handled by the "blocking" method. Liquid sulphur from the sulphur plant is stored in pits to allow production gauging. From the pits the liquid sulphur is pumped to the cooling and slating belts of the slater unit. The formed slates are moved to a storage area by conveyor belts to await loading on unit rail cars. A schematic of the handling operation is presented in Figure 5.

4.1.5.2 Sulphur Dust Monitoring

The slating operation, while reducing sulphur dust significantly, still allows some dust to settle downwind of the sulphur loading area. Sulphur dustfall is measured in accordance with Department of Environment air monitoring directives by 12 sulphur dustfall monitoring stations located around the sulphur storage and shipping route area. The results are analyzed by a contract laboratory and the results submitted monthly to the Department of the Environment. Although there is no specified limit for sulphur dustfall the ambient air quality criteria for Alberta stipulates a maximum allowable total dustfall for industrial areas of 45 tons per square mile per 30 days and for urban areas 15 tons. The average sulphur dustfall downwind of the Waterton sulphur loading area does not exceed either limit.

In addition to reducing sulphur dust by slating and measuring it with dustfall cylinders, the effects of sulphur dust are controlled by reclaiming acidified soil and by collecting and treating surface run-off water.

4.1.5.3 Soil Reclamation

Elemental sulphur dust absorbed by the soil is converted to sulphuric acid by certain soil bacteria. The resultant soil acidification may be injurious to plants. Dr. M. Nyborg of the University of Alberta conducted studies and tests at a Shell plant to determine the feasibility of reclaiming acidified soil. He was able to successfully demonstrate that neutralization with calcium carbonate followed by normal agricultural husbandry practices would reclaim the soil.

At the Waterton plant, the area northeast of the sulphur blocks has been subject to extensive reclamation work this summer, utilizing the services and knowledge of Dr. Nyborg. The area nearest the sulphur blocks has been successfully limed, fertilized and seeded. The second phase of the program has been started with soil sampling over a comprehensive grid network farther east of the plant.

4.1.5.4 Surface Run-off Control

Surface run-off water may be contaminated by acidified soil which can reduce the water pH and increase its soluble salt content. To prevent the run-off water from affecting neighbouring watercourses it is collected by a drainage system that routes plant runoff water into large holding ponds (Figure 6). The water is tested and if required, treated before being released to the North Drywood Creek. In addition, the drain system and the ponds prevent elemental sulphur from entering the creek.

4.1.6 Pentanes-Plus Storage

4.1.6.1 Spill Protection

Dikes have been built around all storage tanks to contain any liquids that are inadvertently released and to hold all the liquids in the event of a storage system failure. As an added safety measure any drainage from these storage areas is routed to the surface drainage system holding ponds. In the case of a major spill, the oil or condensate

Figure 5

SCHEMATIC OF SULPHUR SLATING UNIT

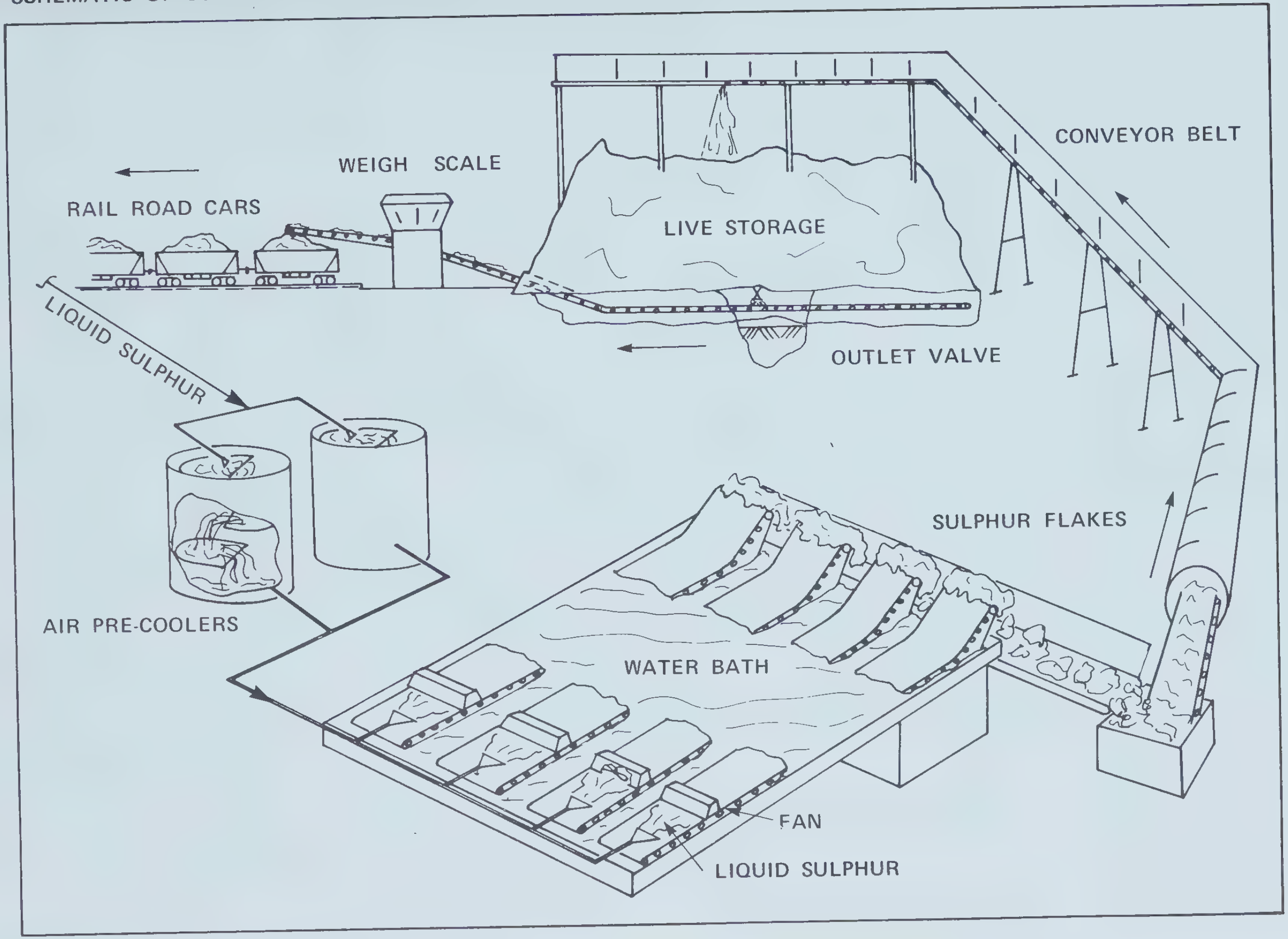
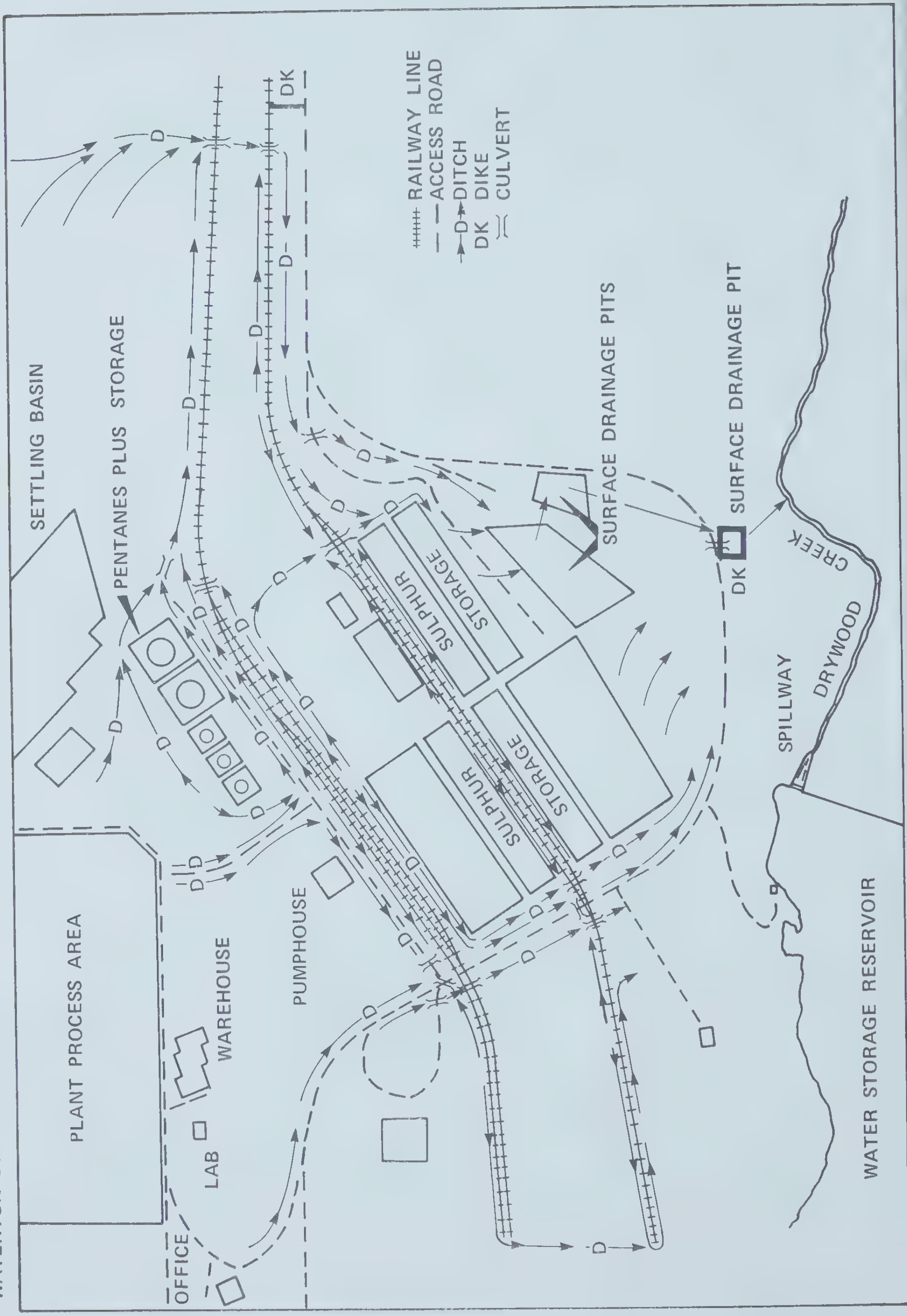


Figure 6

WATERTON SURFACE RUNOFF DRAINAGE SYSTEM



would be skimmed off and returned to the plant for reprocessing. A drain system is necessary in the dikes to drain off accumulated rain water, or melted snow. The drains are normally kept closed.

Any spillage or tank rupture which could present an environmental problem is reported immediately to the E.R.C.B.

4.1.6.2 Product Storage Vapour Handling System

The quality of the pentanes-plus product and the associated volatile gas is controlled by minimizing its vapour pressure. This is done in the process and monitored by daily vapour pressure tests.

A vapour recovery system exists upstream of the pentanes-plus tanks to minimize the amount of vapours reaching the storage tank. The liquid passes through this system allowing volatile gases to be collected and recompressed back into the process system. The vapours which are finally flared represent only the vapours displaced during the tank filling operation and only from those tanks without floating roofs.

The vapours from the pentanes-plus storage tanks are routed to a separate flare system. To reduce smoke and to ensure complete combustion, a specially designed flare tip utilizing steam has been installed on the pentanes-plus flare system.

4.1.6.3 Floating Roof Storage Tank

The pentanes-plus storage tank installed during the recent expansion of the Waterton plant is of a floating roof type. The roof floats on the liquid and is sealed at the edges thus reducing the emission of hydrocarbon vapours.

4.1.6.4 Measurement of Sulphur Content

The amount of hydrogen sulphide in the pentanes-plus is measured by the modified Leco method and recorded on the sulphur balance report which is submitted to the E.R.C.B.

4.1.7 Process Water

4.1.7.1 Waste Water Treating System

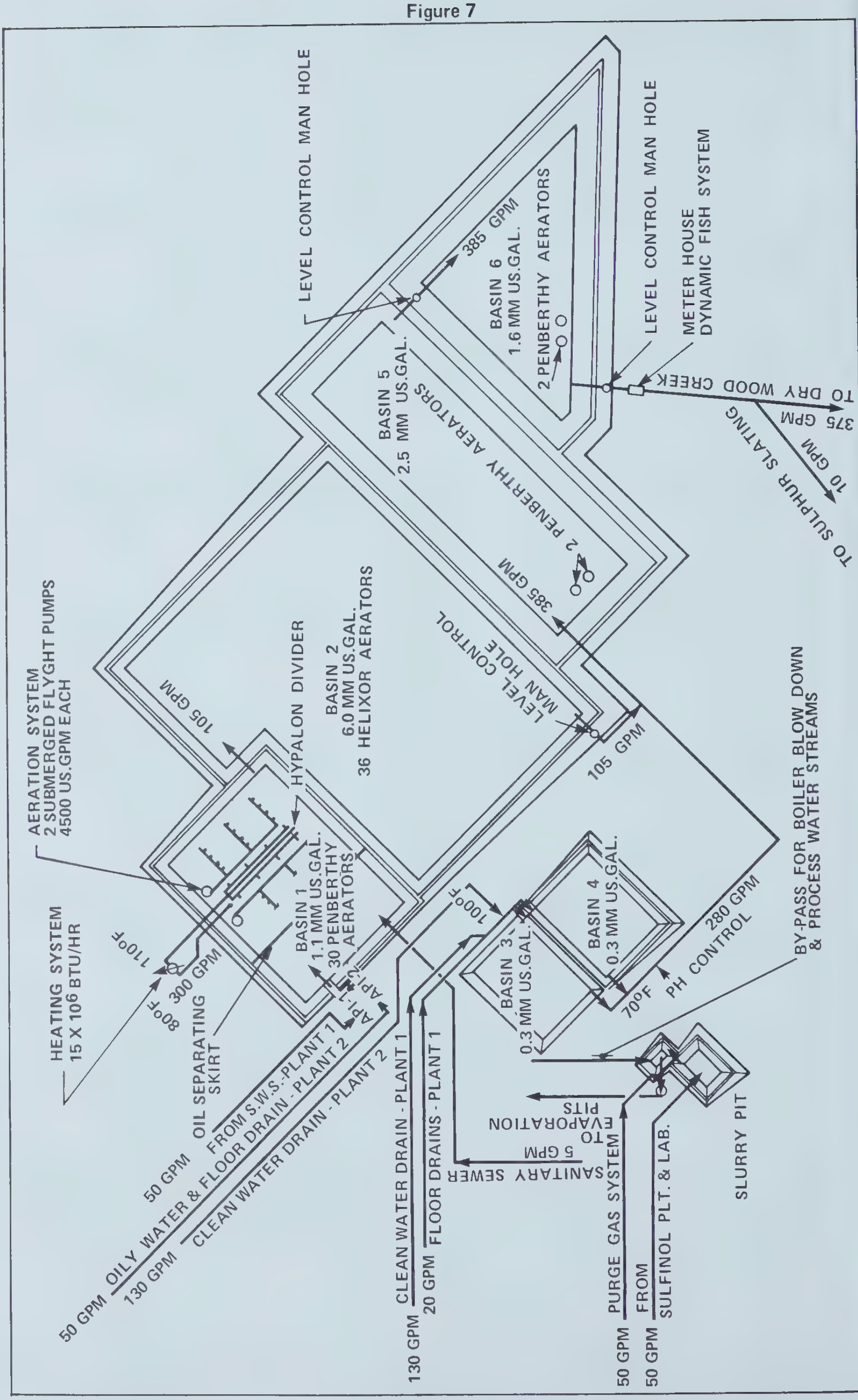
The monitoring and control of waste water disposal involves not only the sampling of the plant effluent itself, but also water courses upstream and downstream of the effluent entry point to the North Drywood Creek.

The waste water is treated by the system shown in Figure 7. Steam stripping and oil skimming units are located at the front end of the treating system to remove dissolved sulphides and oils and greases. Aeration is required to provide oxygen for biological degradation. Two of the basins are heated during the winter to maintain a constant temperature for optimum biological activity.

To assist the treating systems, the waste water drainage system from the plant is designed with maximum flexibility to allow wastes of slow bio degradability to be routed to isolated evaporation pits. In addition, accidental spills and heavy maintenance washings can be routed to the evaporation pits for special treatment and handling to prevent overloading of the waste water treating system.

Figure 7

WATERTON WASTE WATER TREATING SYSTEM



4.1.7.2 Effluent Analyses

Monitoring the operation of the waste water treating system takes many forms. In accordance with the effluent quality approval, analyses as shown in Table 4 are conducted on the effluent. The results of these analyses are sent monthly to the Department of the Environment together with explanations and descriptions of remedial action on any results which exceed specified limits.

4.1.7.3 Additional Water Control Monitoring

To assure high quality effluent requires detailed knowledge of how the waste water is improving as it moves through the treating system. Many control analyses are performed by the plant to ensure the approval is being met. For example, the five day biological oxygen demand (B.O.D.) is specified in the approval and the plant conducts analyses accordingly. However, a single analysis requires five days to complete which is too late to correct the cause if something is wrong in the system. To provide a more dynamic control system and enable timely corrective action, the plant also conducts chemical oxygen demand (C.O.D.) analyses (a three hour test) plus total carbon, total organic carbon and total inorganic carbon analyses. All of these can be correlated to B.O.D. Table 5 summarizes the analyses conducted on the waste water treating system to ensure that its final product, the plant effluent, meets the specified quality limits.

The Province of Alberta in its surface water quality criteria provides guidelines for limits on many pollutants including trace metals, pesticides and chemicals. The Waterton plant conducts analyses on the items specified in the criteria (Table 6). To provide a complete assessment of the impact of the plant effluent on the surrounding water courses several additional analyses are conducted. These are summarized in Table 7.

The streams in the Waterton area which are sampled and analyzed are listed below:

1. Waterton plant effluent.
2. North Drywood Creek upstream of the effluent entry point.
3. North Drywood Creek 100 yards downstream of the effluent entry point.
4. Downstream of the confluence of the North and South Drywood Creeks.
5. A point upstream of all Waterton wells.

4.1.7.4 Static and Dynamic Fish Bio-assay Monitoring Systems

One of the most significant and important monitoring techniques used at the plant is the fish bio-assay system. The system which the plant maintains for this purpose follows the recommendations of the U.S. Environmental Protection Agency. The fish used are trout fingerlings acclimatized to the Drywood Creek conditions.

All chemicals used in the plant which could enter the waste water treating system are tested for toxicity. The method used is the standard bio-assay in a static system. The chemicals tested by this method are shown in Table 8. These tests have resulted in the rejection of several chemicals and the implementation of strict controls on others.

In addition to the static fish bio-assay, a dynamic fish tank system exists at the Waterton plant. In this system, part of the effluent stream is diverted and flows through a tank containing trout fingerlings. The flow is continuous, parellels the remainder of the effluent and requires that the fish live in 100 percent plant effluent. The objective of the dynamic fish tank system is to provide a continuous toxicity indicator using an indigenous species of fish, in this case, trout. This system covers all trace chemicals which are toxic.

Table 4

WATER POLLUTION APPROVAL No. 100-S-1969 ANALYSES

Steam	Analysis Required	Limit/Unit	Frequency Required	Frequency Conducted
Effluent	B.O.D.-5 day-20°C	150 lbs/day	1/week	1/week
Effluent	pH	6.5 to 9.5	1/week	5/week
Effluent	Threshold Odour No. @ 20°C	25	1/8 hours	1/8 hours
Effluent	Oil and Greases	15 mg/1	1/week	1/week
Effluent	Total Sulphides (as H_2S)	0.1 mg/1	1/week	1/week

Table 5

WASTE WATER TREATING SYSTEM ANALYSES

Analyses Conducted	Basin No. 1	Basin No. 2	Basin No. 3/4	Basin No. 5	Effluent
Dissolved Oxygen	1/week	1/week	1/week	1/week	1/week
Biological Oxygen Demand - 5 day - 20°C		1/week	1/week	1/week	1/week
pH		5/week	3/week	5/week	5/week
Temperature		3/week		3/week	5/week
Chloride		5/week	3/week	5/week	5/week
Conductivity		5/week	3/week	5/week	5/week
Chemical Oxygen Demand	5/week	5/week	5/week	5/week	5/week
Total Carbon	5/week	5/week	5/week	5/week	5/week
Total Organic Carbon	5/week	5/week	5/week	5/week	5/week
Total Inorganic Carbon	5/week	5/week	5/week	5/week	5/week
Alkalinity					1/week
Total Solids					1/week
Suspended Solids					1/week
Dissolved Solids					1/week

Table 6

SURFACE WATER QUALITY CRITERIA ANALYSES (PROVINCE OF ALBERTA)

Analyses Conducted	Limit-Units	Effluent	North Drywood Plus Effluent	North Drywood	North Drywood Above Farthest Well	Confluence N & S Drywood
Total Coliform	5000/100ml	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Fecal Coliform	1000/100ml	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Dissolved Oxygen	5 ppm	Daily	4/Yr	4/Yr	4/Yr	4/Yr
Temperature	+3°C above amb.	3/Wk	4/Yr	4/Yr	4/Yr	4/Yr
Color	30 above background	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Turbidity	25 above natural	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Carbon Chloroform Extract	0.2 ppm	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Methyl Mercaptan	0.05 ppm	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Methylene Blue Active	0.5 ppm	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Phenolics	0.005 ppm	1/Mo	4/Yr	4/Yr	4/Yr	4/Yr
Resin Acids	0.1 ppm	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Boron	0.5 ppm	4/Yr	4/Yr	4/Yr	4/Yr	4/Yr
Copper	0.02 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Fluoride	1.5 ppm	1/Mo	1/Mo	4/Yr	4/Yr	4/Yr
Iron	0.3 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Manganese	0.05 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Nitrogen (NH_3 - NO_3)	1.0 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Phosphorous PO_4	0.15 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Sodium	30-75%	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Sulphide	0.05 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Zinc	0.05 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Arsenic	0.01 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Cadmium	0.01 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Barium	1.0 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Chromium	0.05 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Cyanide	0.01 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Suspended Solids	10 above background	1/Wk	1/Mo	4/Yr	4/Yr	4/Yr
Lead	0.05 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Mercury	0.0001 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Selenium	0.01 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Silver	0.01 ppm	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr

Table 7

SPECIAL WATER ANALYSES

Analyses Conducted	Effluent	North Drywood Plus Effluent	North Drywood	North Drywood Above Farthest Well	Confluence N & S Drywood
Dissolved Solids	1/Wk	1/Mo	1/Mo	4/Yr	4/Yr
Total Solids	1/Wk	1/Mo	1/Mo	4/Yr	4/Yr
Organic (ether Sol)	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Hydroxide	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Carbonate	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Bicarbonate	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Sulphate	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Chloride	5/Wk	1/Mo	1/Mo	4/Yr	4/Yr
Silica	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Hardness	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Calcium	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Magnesium	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Aluminium	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Antimony	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Tin	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Nitrate	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Ammonia	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
Microbiological	1/Mo	1/Mo	1/Mo	4/Yr	4/Yr
COD	5/Wk	1/Mo	1/Mo	4/Yr	4/Yr
Invertebrate(1)		4/Yr	4/Yr		
Conductivity	5/Wk	1/Mo	1/Mo	4/Yr	4/Yr

(1) Invertebrate sampling requested by the Fish and Wildlife Department. The Water Resources Office Interim License No. 6792 while not requiring Shell to conduct the analyses states that the results of the test should show that at least 50% (quantity) of certain invertebrate organisms living upstream of the effluent entry point should be living downstream of it.

Table 8

CHEMICALS TESTED BY STANDARD BIOASSAY

Test No.	Chemical	In Use	Conc. Used In Plant	Conc. Tested	Lethal Conc.	Non Lethal Conc.	Remarks
1	Drew Biocide 201	No	-	10 ppm	10 ppm		
2	Drew Biocide 207	No		10 ppm	10 ppm		
3,10,12	Calgon TG 10	No	-	18,12,6	8,12 ppm	6 ppm	
4	Betz 408	Yes	1.5-3.0	3 ppm		3 ppm	
5	Betz Liqui Treat	No	660 ppm	600 ppm		600 ppm	
6,7,8	H.T.H.	Yes	0.1 ppm max.	1.0,0.1	1.0,0.1	0.05 ppm	
9,11	Sulphuric Acid	Yes	To reduce pH to 6.8-7.0	20 ppm (pH 6.9) 10 ppm (pH 7.4)	20 ppm	10 ppm	
13	Betz Adjunct	Yes	20-40 ppm	40 ppm		40 ppm	
14,18,30	Betz Poly-Floc 1179	Ponds	-	24,15,5	24,15 ppm	5 ppm	
15	Betz Octafilm	Yes	2-4 ppm	4 ppm		4 ppm	
16,17	Betz Liqui Treat 375	Yes	4 ppm	4 ppm		4 ppm	
19,21,27	Betz - 55D	Yes	12-20 ppm	20,10,60 ppm		20,10,60 ppm	
20,22	Betz 403	No	-	6,3 ppm	6 ppm	3 ppm	
23,24, 25,26	Algicide TXP	No	-	1,1.5,2.0, 0.5 ppm	1,1,5,2.0 0.5 ppm		
28	Betz DE 364 Biocide and Sodium Sulfite	Intended	-	0.5 ppm DE 364 + 1.5 ppm Sodium Sulfite (1:3)		(0.5 ppm: 1.5 ppm)	Non-Lethal at 0.5 ppm only if neutralized with 1.5 ppm Sodium Sulfite
29	Neutrameen	Yes	1.0 ppm	0.5 ppm		0.5 ppm	Partially used to react CO_2
31	Betz DE 364 Biocide and Sodium Sulfite (2.0 ppm: 4.0 ppm)	Intended		2.0 ppm DE 364 + 4.0 ppm Sodium Sulfite (1:2)		2.0 ppm:	Non-Lethal at 2.0 ppm if neutralized with 4.0 ppm Sodium Sulfite
32	Betz DE 364 Biocide	No		2.0 ppm	2.0 ppm		This test done as a follow up to No. 28 and No.31
33	Oakite 79	Yes	-	20 ppm	20 ppm		-
34,35, 36	Cleaner Soln. NP 77	No		0.67%, 0.1% 0.05%	0.67%, 0.1% 0.05%	Unknown	-
38,39	Betz 1810	Yes	0.2 ppm	3,1.5 ppm	3 ppm	1.5 ppm	-
40	Betz DA364	No		1%	1%	Unknown	-
41	Pre-film 106	No		1%	1%	Unknown	0.25% Also lethal test not conducted due to D.O. problem
44,45	Bio Pur 10			10 ppm	Unknown	10 ppm	-
46	C_5	10 ppm		20 ppm	20 ppm	Unknown	No aeration
48	C_5	10 ppm		10,5 ppm	-	10,5 ppm	Water aerated for 3 days prior to test
49	Polycomplex All	No		100 ppm	100 ppm	Unknown	-

4.1.7.5 Summary of the Waste Water Monitoring System at the Waterton Plant

Many types of organisms are required to produce an overall healthy stream. It is recognized that because of the varied mineral composition of a stream it may be invalid to use single values for specifying safe limits on any single toxic chemical because of synergistic effects. Therefore the bio-assay method is favoured by many authorities for determining the toxicity of waste water. For this reason the Waterton plant is using both static and dynamic fish bio-assay methods to monitor toxicity levels of the plant effluent. This approach combined with measurements of pH, temperature and B.O.D. provides the most desirable system for monitoring effluent quality.

4.2 WATERTON PLANT PERFORMANCE

4.2.1 Introduction

As this brief has attempted to show, maximum limits have been set on specific chemical pollutants. Operations are strictly controlled within these limits. However, having regard for the complexity of plant operations and the physical limitations of men and equipment upsets can and do occur – and the law provides for these. Where a stipulated maximum limit has been exceeded the onus is on the operator to explain the occurrence to the ERCB and should a satisfactory explanation not be forthcoming the operator may be subject to prosecution.

4.2.2 Maintaining Air Quality

4.2.2.1 Sulphur Dioxide Emission Levels

The waste gases from the sulphur plant emitted to the atmosphere through the 500 foot disposal stack contain sulphur dioxide. The maximum allowable sulphur dioxide emissions are stipulated in E.R.C.B. Approval 1394. Figure 8A shows our performance compared to the E.R.C.B. maximum daily sulphur dioxide emission limit for the past three years. The raw gas throughput is also presented on Figure 8B indicating the increased capacity with the start-up of the No. 2 plant in late 1971. The maximum daily sulphur dioxide limit was exceeded only once during the three year period.

In late 1971 the continuous stack emissions monitor (CSEM) was installed on the stack. This allowed the measurement and calculation of half-hour stack emissions. On Figure 8C the percentage of operating time (hours) during which the half-hour sulphur dioxide emission levels were being exceeded is shown. Operating problems which caused the half hour emissions to exceed the specified limit represent less than one percent of the operating time Conversely, the sulphur plant was operating within the limit for over 99 percent of the time.

4.2.2.2 Incinerator Stack Top Temperature

Thermocouples in the stack continuously monitor the stack top temperature and a record of the results is printed out in the plant control room. Figure 9 shows the monthly average of daily minimum stack top temperatures, as well as the percentage of operating time during which the stack top temperature was below 1000°F. Although the stack top temperature did on occasion fall below the specified limit, at no time did it cause the average daily stack top temperature to fall below the limit. In terms of continuous performance the incinerator system reliability has been in excess of 99 percent over the past three years.

Figure 8

WATERTON SULPHUR DIOXIDE EMISSION AND PLANT RAW GAS THROUGHPUT

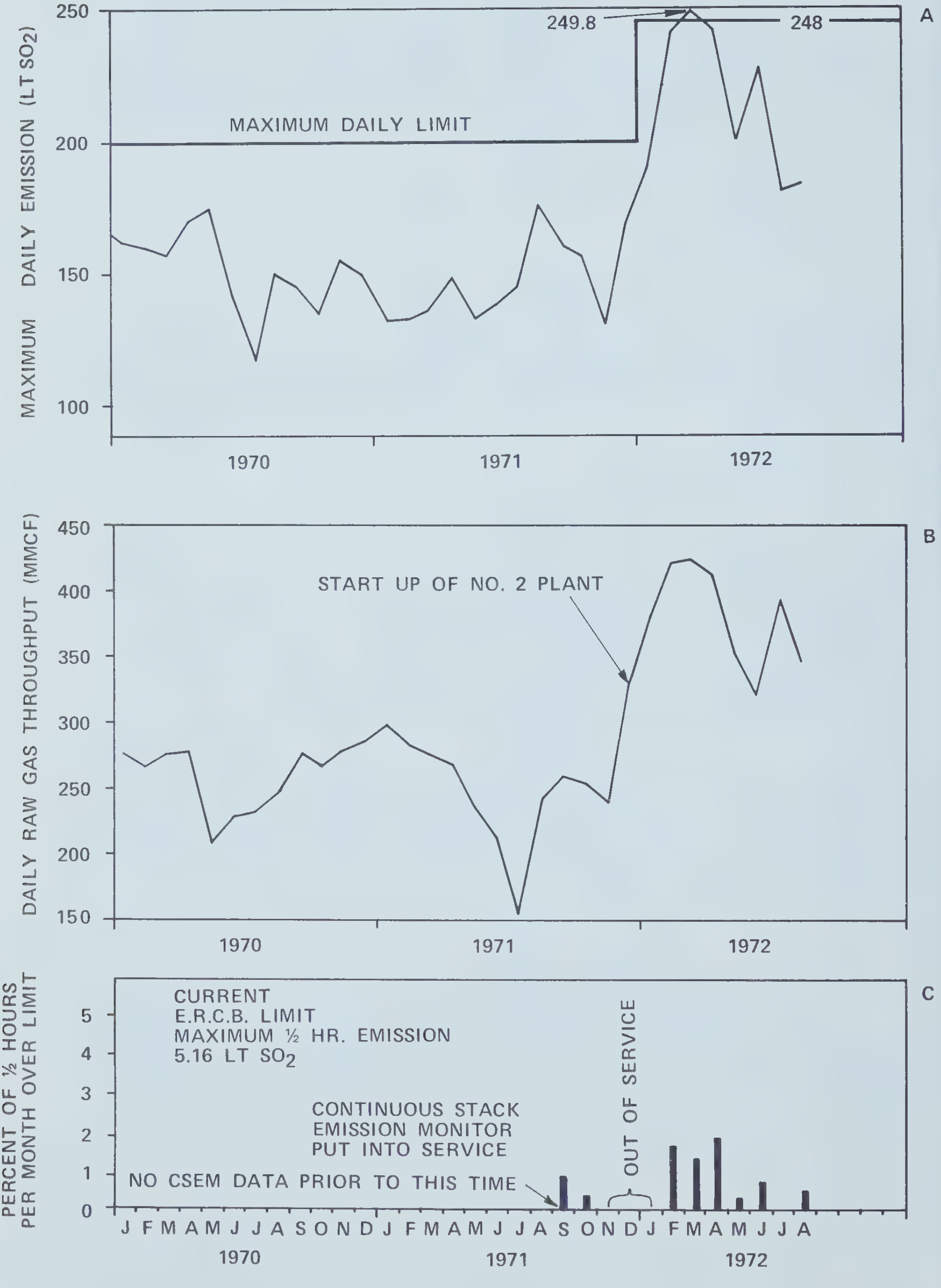
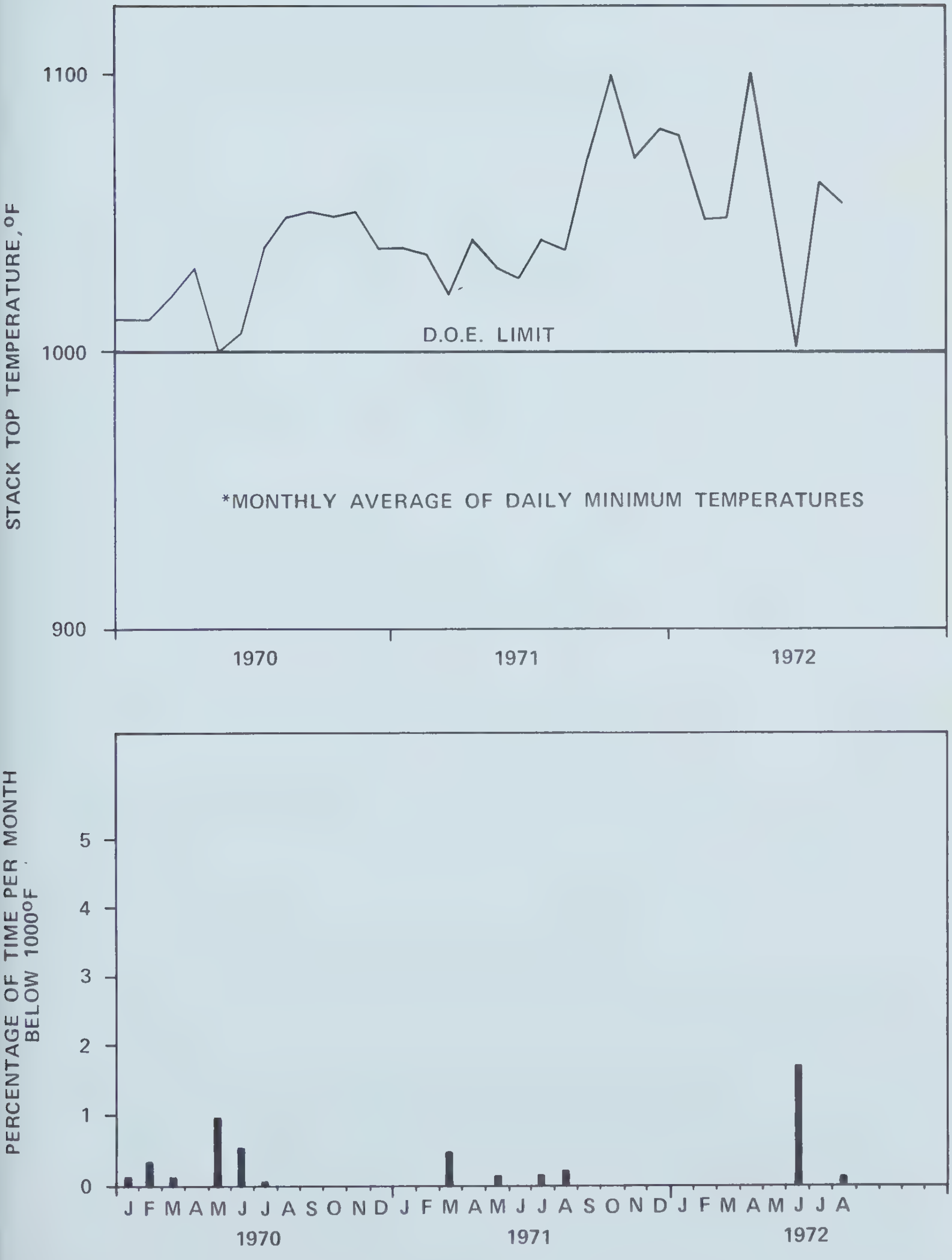


Figure 9

WATERTON AVERAGE MINIMUM STACK TOP TEMPERATURES* AND PERCENTAGE OF TIME PER MONTH BELOW DEPARTMENT OF ENVIRONMENT LIMIT OF 1000°F



4.2.2.3 Sulphation Exposure Cylinders

The sulphation exposure cylinder results for total sulphation and hydrogen sulphide are shown in Figure 10. Each point represents a monthly station reading. There are 39 stations in the grid. Since January 1, 1970, there have been 15 occasions that a total sulphation cylinder has exceeded the suggested guideline. This represents approximately 99 percent performance. During the same period, the hydrogen sulphide cylinder performance (also measured in total sulphation readings) was 92 percent.

The results from the cylinders have provided data to establish the downwind pattern of sulphation. These data have been used to locate the air quality monitoring trailers and have provided the basis for a ground level sulphur dioxide concentration study utilizing the mobile radio telemetered trailer.

4.2.2.4 Ground Level Sulphur Dioxide Concentrations

The sulphur dioxide ground level data from the air quality trailer located at LSD 7 of Sec. 25 Twp. 4 R. 30 W 4M are presented in Figure 1 for 1970 through July, 1972. Since January 1, 1970, the calculated average daily concentration levels exceeded the Department of the Environment criteria during the months of April and May, 1971. The calculated results for these months were based on the calibration curves developed by a contract specialist. A later calibration by Shell laboratory personnel indicated that the calibration curves for April and May were high by a factor of almost two. However, the results reported to the Department of the Environment were not amended because it could not be specifically determined when the sensitivity of the instrument had changed. Subsequent calibrations of the instrument by the same contract specialists confirmed the calibration curves developed by the Shell personnel. This experience emphasizes the practical problems that occur when applying new technology to achieve rigid environmental objectives.

The percentage of hours per month during which the Department of the Environment criteria were exceeded are shown in Figure 11B while the percentage of half-hours per month during which the E.R.C.B. limit were exceeded are shown in Figure 11A. Although the plant has on occasion exceeded the hourly criteria and half-hour regulation, its overall performance with regard to ground level concentrations has been in excess of 99 percent.

The air quality trailer located at LSD 9 of Sec. 30 Twp. 4 R. 29 W 4M in Figure 12 provided similar data except that the occasions of relatively high sulphur dioxide ground level concentrations were less frequent.

Shell has installed three additional air quality trailers to give a total of five, all with telemetry equipment. This allows the plant to take immediate action when limits are being approached thus ensuring an even better environmental performance at the Waterton Plant.

4.2.3 Maintaining Water Quality

4.2.3.1 Effluent Quality Record

The effluent results are shown in Figure 13 for the period 1970 through July, 1972. The threshold odor number, oil and greases, pH and total sulphides are all within the Department of the Environment approval limits. The approval also requires that the B.O.D. of the effluent be reduced to 150 pounds per day.

The effluent B.O.D. exceeded limits during early 1971. This was caused by unusually cold winter weather which reduced biological activity in the waste water system. As a result the aeration system was extended to improve biological activity and also to provide for the increased waste water load with the start-up of No. 2 plant.

Figure 10

SULPHATION RESULTS FOR WATERTON AREA

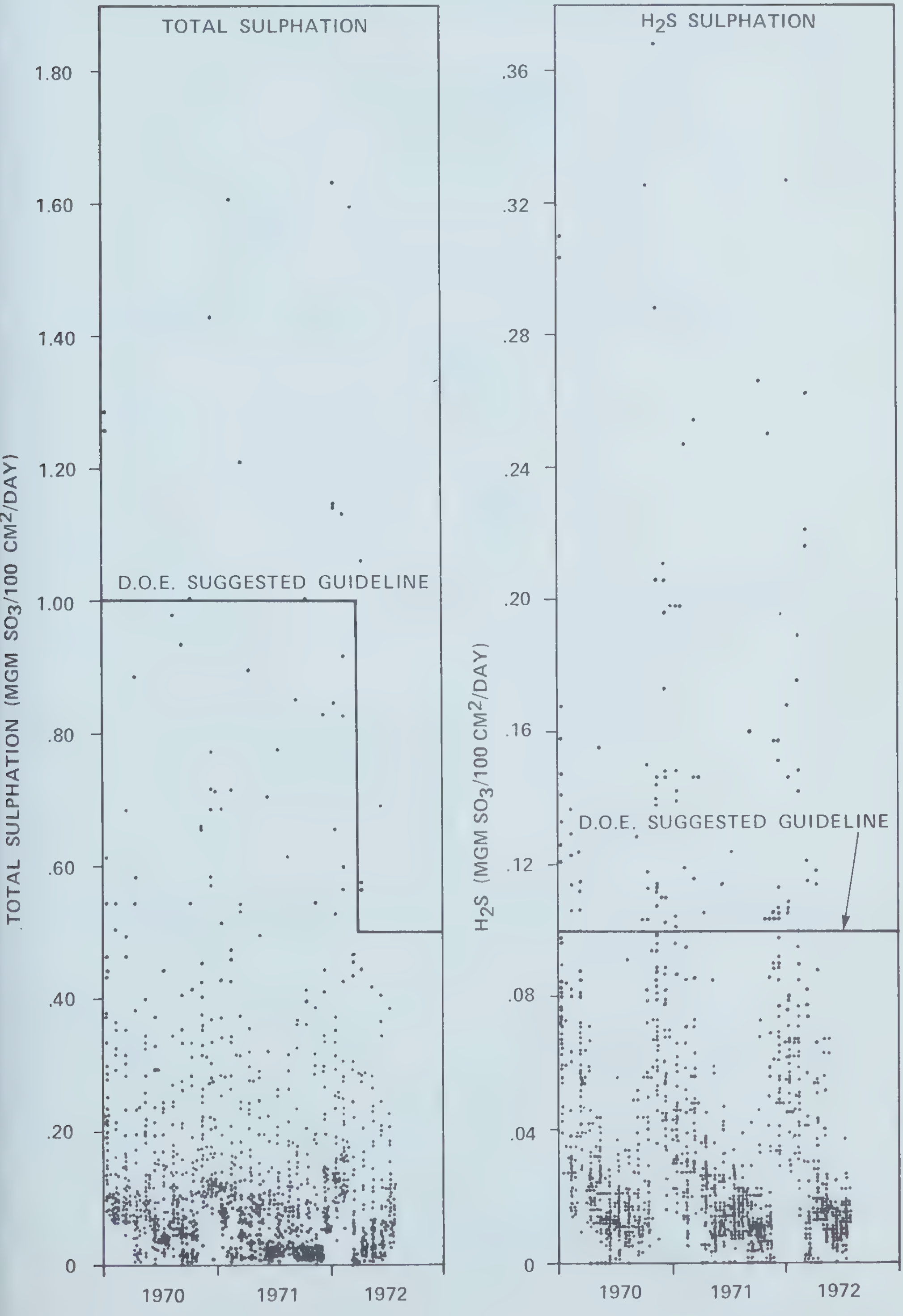


Figure 11

GROUND LEVEL SULPHUR DIOXIDE CONCENTRATIONS (LSD 7-25-4-30 W4M)

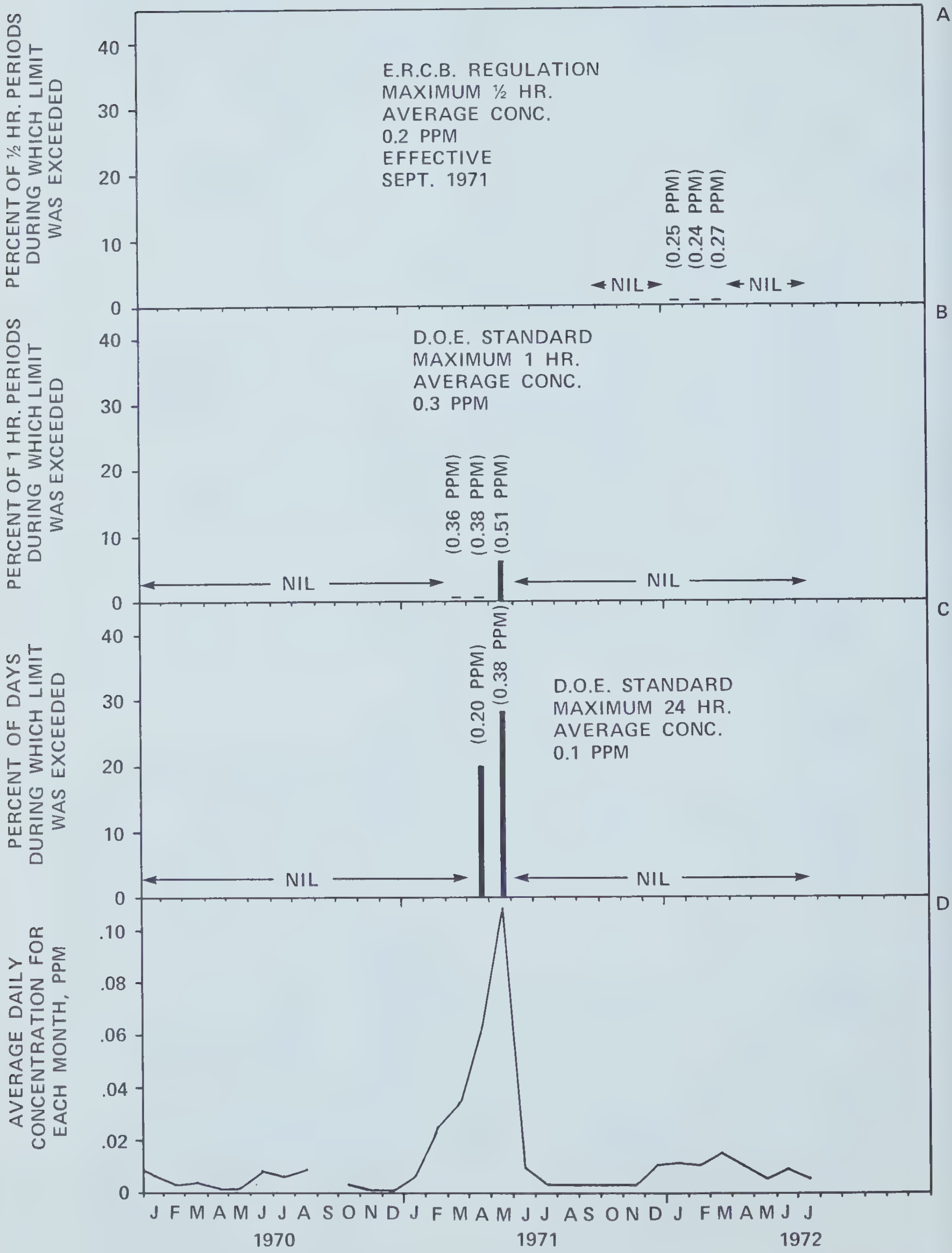


Figure 12

GROUND LEVEL SULPHUR DIOXIDE CONCENTRATIONS (LSD 9-30-4-29 W4M)

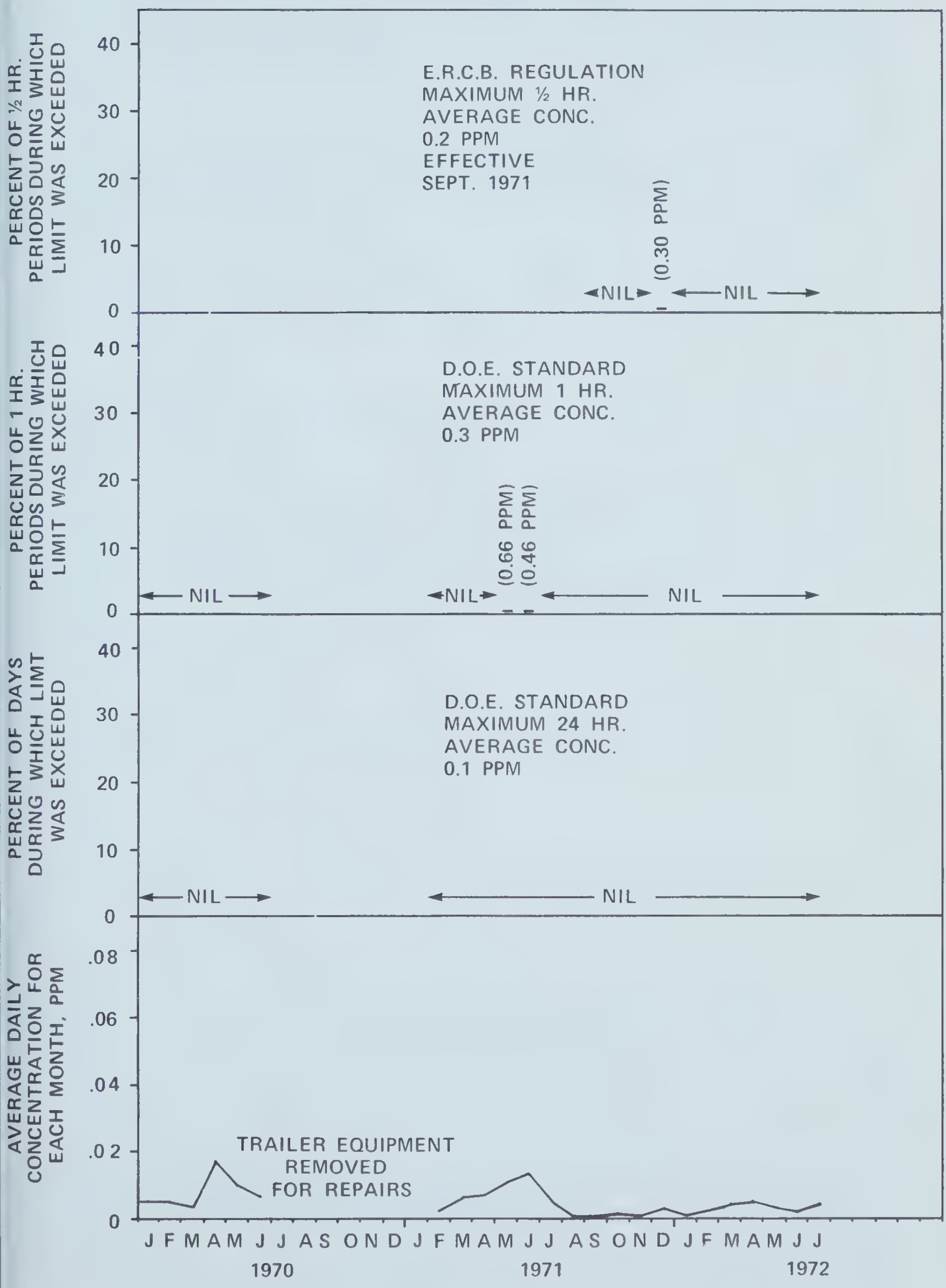
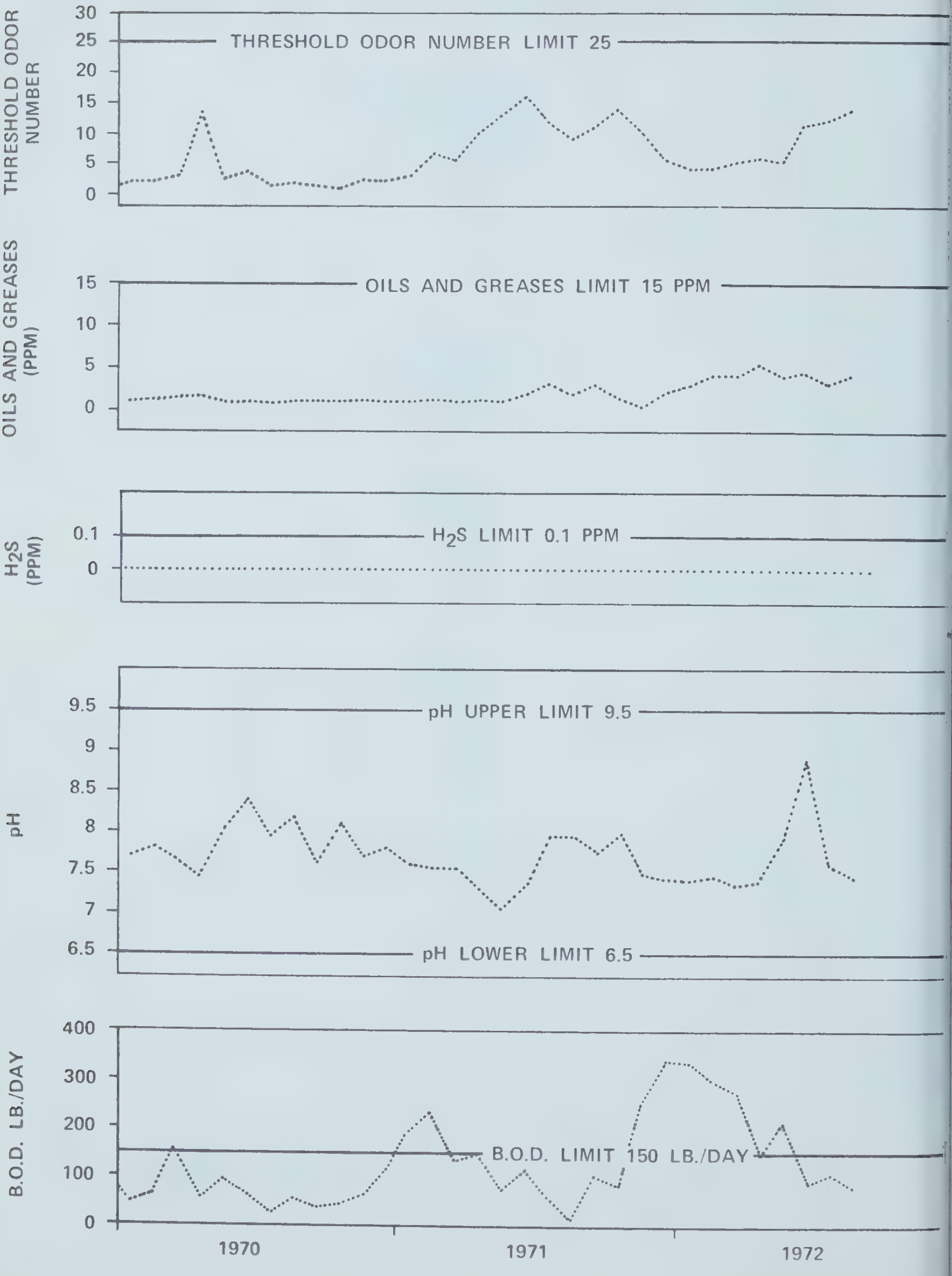


Figure 13

WATERTON WASTE WATER EFFLUENT ANALYSES



To offset the effects of cold weather, Shell initiated the design of a heating system for the treating basins. Because of initial technical design problems, the heating facilities were not completed until March, 1972. As a result the problem of reduced biological activity was again evident during the 1971-72 winter period. The problem was further complicated by the faulty construction of the waste water pipeline from plant No. 2 which allowed high B.O.D. water to mix with partially treated water. Extensive water analyses and equipment check-outs were necessary before the fault was finally located. Following location of the fault corrective action was taken immediately.

During these periods of high effluent B.O.D. the specified quality limits for threshold odor number, oils and greases, hydrogen sulphide and pH were not exceeded. In addition, the dynamic fish bio-assay monitoring system indicated that the effluent was safe to human health and livestock, and capable of supporting fresh water organisms, including fish.

Extensive studies are currently underway to further improve the performance of the waste water treating system with regard to B.O.D. reduction and control. At present an activated biological sludge system is being investigated for implementation in the Waterton waste water treating system.

4.2.3.2 Surface Water Quality Results

Water analyses are conducted on the effluent and surrounding watercourses to ensure that the plant effluent does not contribute trace chemicals to the North Drywood Creek in excess of those recommended by the Department of the Environment in their surface water quality criteria.

The control analyses for July, 1972 is shown in Table 9. This analysis is typical of the data collected during the last year. Of the heavy metals measured in the plant effluent only iron has occasionally exceeded the suggested criteria. However, the amount of iron measured in the Drywood Creek downstream from the plant has not exceeded the water quality limits. The occasional excess iron in the plant effluent is the result of corrosion in the process water cooling system. The corrosion problem is under review prior to implementation of corrective measures.

Table 9

QUARTERLY AMBIENT WATER QUALITY ANALYSES

July 5, 1972

	100 Yards Upstream from furthest West Well	Creek Upstream of Effluent	Waterton Plant Effluent	Creek Plus Effluent	Downstream from Junction of N. & S. Drywood Creek	Water Quality Limits
pH Value	8.0	8.2	8.0	8.2	8.2	6.5-9.5
Color	0	0	15	0	5	-
Conductivity (micromhos/cm)	133	204	1000	211	238	
T.O.N.	1	1	10	1	1	25
Turbidity (J.T.U.)	1	2	45	2	10	-
Concentrations	mg/1	mg/1	mg/1	mg/1	mg/1	mg/l
Hydroxide (OH)	0.0	0.0	0.0	0.0	0.0	
Carbonate (CO_3)	0.0	0.0	0.0	0.0	0.0	-
Bicarbonate (HCO_3)	59	114	106	114	138	-
Sulphate (SO_4)	23	22	152	23	19	-
Chloride (Cl)	1.0	1.0	176	2	2	-
Nitrate (NO_3)	0.1	0.1	0.2	0.1	0.1	-
Phosphate (PO_4)	0.0	0.0	2.2	0.0	0.0	-
Silica (SIO_2)	4	3	7	3	4	-
Hardness (as $CaCO_3$)	64	104	248	106	122	-
Calcium	16	26	65	27	31	-
Magnesium (Mg)	6	10	33	9	11	-
Zinc	0.0	0.0	0.0	0.0	0.0	.05
Iron (Fe)	0.05	0.1	1.1	0.1	0.2	0.3
Copper (Cu)	0.0	0.0	0.0	0.0	0.0	0.02
Aluminum (Al)	0.0	0.0	0.3	0.0	0.0	-
Sodium (Na)	5	6	114	7	7	-
Organic ((Ether Soluble)	0.1	0.1	1.3	0.2	0.1	-
Dissolved Solids	114	182	655	185	212	-
Suspended Solids	3	4	43	4	16	-
Ammonia (NH_3)	0.05	0.05	0.6	0.1	0.05	-
Fluoride	0.1	0.1	0.1	0.1	0.1	1.5
Total Sulfides	0.0	0.0	0.0	0.0	0.0	0.1
Antimony	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-
Arsenic	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Barium	0.2	< 0.1	0.2	0.1	0.1	1.0
Boron	< 0.1	< 0.1	0.3	0.1	< 0.1	0.5
Cadmium	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Chromium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Lead	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05
Manganese	< 0.05	< 0.05	0.1	< 0.05	< 0.05	0.05
Mercury	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.000
Silver	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.01
Selenium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01
Tin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-
Phenol	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005
Cyanide	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Surfactant (MBAS)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5

5. PROGRAMS UNDER STUDY FOR IMPROVED ENVIRONMENTAL CONTROL AT WATERTON

5.1 AIR QUALITY ENVIRONMENTAL PROGRAMS

5.1.1 Sulphur Plant Stack Gas Clean-up

In November, 1971 the E.R.C.B. issued guidelines requiring increased sulphur plant recovery efficiencies for the sulphur extraction industry in Alberta, effective December 31, 1974.

The guidelines are designed on a sliding scale such that the larger the sulphur plant the higher the efficiency required. For the Waterton complex a sulphur plant recovery efficiency of 98 to 99 percent will be required to meet the guidelines.

There is virtually no industrial experience to draw from regarding very large, high efficiency tail gas recovery units capable of achieving 99+ percent. Shell's review of the most promising processes indicates that the capital expenditure required to modify the existing Waterton facilities for a tail-gas clean-up unit together with the installation of the prototype will be in excess of $10 million with an annual operating cost of approximately $1 million.

5.1.2 Liquid Sulphur Degasification

The liquid sulphur slating operation is a source of hydrogen sulphide and sulphur dioxide. These gaseous emissions will be controlled by the addition of a degasification unit for the liquid sulphur. The object of the system is to remove dissolved hydrogen sulphide and sulphur dioxide from the liquid sulphur before it reaches the slating operation and thus prevent these gases from being emitted to the atmosphere at ground level. The evolved gases will be routed to the incinerator for complete combustion and disposal up the 500 foot stack. Ground level concentrations and present odors in the area resulting from the sulphur pouring operation should be virtually eliminated.

The process is new in North America and will be unique to the Waterton Plant. At present, mechanical design is underway and construction will commence in the fall of 1972. The facilities, estimated to cost $1.6 million will be operational by mid 1973.

5.1.3 Air Quality Monitoring Program

To provide a flexible monitoring system, one of the five new monitoring trailers is equipped with radio telemetry. Future programs with this mobile trailer include a detailed survey of key areas east of the plant to substantiate the historical sulphation cylinder results. The mobile trailer will provide the desired flexibility in the air quality monitoring system and allow a more accurate assessment of the progress of the Environmental control program.

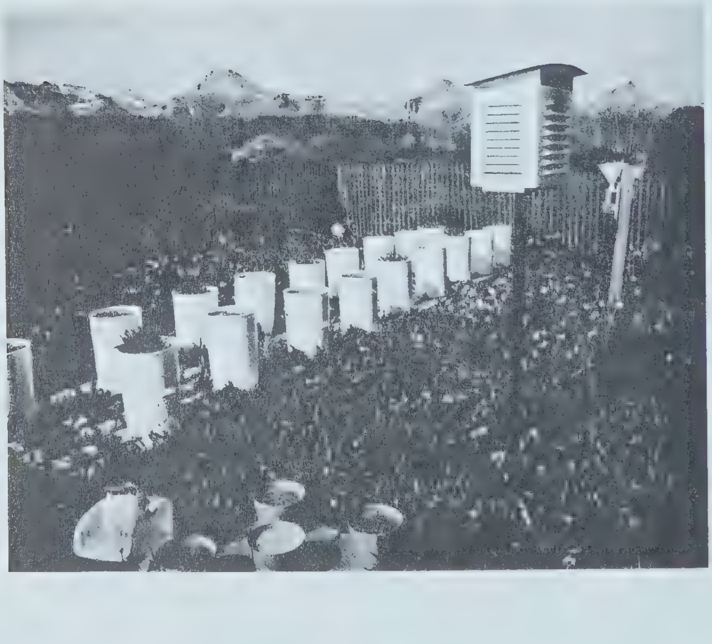
5.1.4 Study of Emission Effects

Shell has contracted a firm of agricultural consultants to conduct studies of the effects of gas plant emissions on crops and livestock in the Waterton plant area.

The initial study, started in June, 1972, is designed to constructively assess the effect of the environment on vegetation. Alfalfa, barley and brome grass have been grown under controlled conditions of soil, fertilizer, seeding and moisture in experimental pots at twelve sites (Figure 14). Six sites are located in the indicated emission zone while six control sites are located outside the emission zone. Evaluation and interpretation of the results are presently underway. The objective is to assess the cause/effect relationship in plant growth and yield under existing emission levels.

Figure 14

WATERTON VEGETATION TEST PLOTS



Field plots at these same locations have been cultivated in preparation for growing alfalfa, barley and brome grass next year under actual field conditions.

A second study involving a livestock program is in the final stages of design and will get underway this fall. The objective of this program is to compare the performance of selected animals within and outside the emission zone. The attempt will be to measure rate of gain, disease problems and fertility.

The cost of the overall program during the next two years will be in excess of $300,000.

5.2 WATER QUALITY ENVIRONMENTAL PROGRAMS

5.2.1 Activated Biological Sludge

The waste water treating system utilizes aerated lagoons and biological degradation of waste material to produce a high quality effluent. This system is not capable of handling a wide variation of waste loads on a continuous basis and if overloaded as a result of an upset condition from the plant the treating system takes a long time to recover.

To improve the flexibility of the waste water treating system and to increase the rate of biological degradation of wastes it is necessary to concentrate (activate) the biological mass in an activated sludge unit. This is accomplished by taking the effluent from such a unit, clarifying it and re-cycling the bio-mass to maintain a high sludge concentration in the activated sludge unit. The treated clarified effluent would then be monitored, analyzed and allowed to enter the North Drywood Creek.

A consultant has been engaged to conduct laboratory and field pilot plant tests on degradation of plant wastes utilizing activated biological sludge. Process design, equipment sizing and operating parameters will be determined from these tests.

Assuming successful completion of the activated sludge studies and contingent on the Department of the Environment's approval of the final process design, construction of the activated sludge facilities would be completed by mid 1973. The proposed budget for the project is $500,000.

5.2.2 Waste Water Incineration

The proposed activated sludge treating system is a biological system. Certain low volume plant streams are difficult to bio-degrade. To prevent them from contaminating the activated sludge system, incineration is being investigated as a viable method for disposal of these specific streams.

The Department of the Environment has given tentative oral approval to this concept of waste water handling. Their final approval will be contingent on incineration being part of a total system which includes activated sludge, and on a detailed analysis of the effects of incineration on air pollution.

Preliminary estimates for the project indicate total construction costs in the order of $500,000.

5.3 LAND QUALITY ENVIRONMENTAL PROGRAMS

5.3.1 Soil Reclamation

The Waterton plant area immediately north-east of the sulphur storage area has been successfully reclaimed. The next phase of the program will be dependant on the grid survey samples presently being collected farther east of the storage blocks for analyses. Further soil reclamation may be conducted in 1973 based on the grid survey findings.

5.3.2 Infra-Red Studies

Infra-red photo analyses have been conducted by Shell over the Waterton area. These aerial surveys were begun in 1970 and will probably continue on an annual basis until 1976. The cost of the program is approximately $20,000 for the Waterton plant alone. Five other Shell operated plants are also involved in the program.

The objectives of the infra-red photo survey are to establish background information on vegetation growth in the area. Annual comparisons are made to monitor growth patterns and to identify the extent, frequency and source of any damage.

5.3.3 Plant Surface Drainage System

The entire plant drainage system was modified and reworked during the past summer to improve the surface drainage network and to route the drains to the holding basins for treatment, if necessary. The next phase of the program will be the grassing and landscaping of the area to prevent soil erosion and to improve its appearance.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

There is one question I would like to ask on the probable yield of the field, or fields, that this plant serves; and the total amount of sulphur that may be recoverable, assuming the levels you are going to reach -- 98-99%.

MR. R.G. NADEN

At the ultimate levels? Total capacity would be in the order of 2900 tons a day.

DR. S.B. SMITH

Well, I was thinking more of the absolute when the field is worked out - number of years at, say, three hundred million cubic feet that you've been ...

MR. R.G. NADEN

Oh, our field will be going into decline in the early 1980's.

DR. S.B. SMITH

And it might be worked out by 2000 or something like that?

MR. R.G. NADEN

A field normally is designed, or a facility is normally designed, on a total life of 25 years. So that's reasonably close. Ours though, has been building up because it is a very complex field to evaluate. Its life probably would be longer; but, as I say, it will be going into decline in the early '80's.

DR. S.B. SMITH

So, total tons per year - 3,000 a day, would you say roughly?

MR. R.G. NADEN

That's capacity - average annual tonnnage would probably be 2,000, from now until decline - and then when decline starts, of course, you start heading down.

DR. S.B. SMITH

Two thousand tons a day on an annual basis - so that works out to ...

MR. R.G. NADEN

It's around 836,000 for 1973.

DR. S.B. SMITH

So it will be in excess of half a million tons for the length of the field. Perhaps on the average, would it be ... per year?

MR. R.G. NADEN

It would be less than that, yes. It declines very rapidly.

DR. S.B. SMITH

So that then you hope to get your money back - your $10 million back over that period?

MR. R.G. NADEN

I'm not expecting to. No you would not expect to get your money back.

DR. S.B. SMITH

Thank you.

MR. W.A. FLOOK

Mr. Naden, two or three disconnected questions. The first one concerns the monitoring of the sulphur emissions in your stack. You have a continuous monitoring instrument which presumably measures the contents of H_2S and SO_2 in the gases going up the stack. Does it in fact at the same time measure the temperature at the same point, and speed, the lineal flow of the gas in the stack?

MR. R.G. NADEN

It actually has a computer that reads out in long tons per day, taking into account flow, temperature and all those variables.

MR. W.A. FLOOK

It does measure all these parameters and compute them.

MR. R.G. NADEN

Yes, that's right. On the print-out I should have pointed that out that the instrument is actually reading long tons per day.

MR. W.A. FLOOK

I see, and you have a backup instrument to monitor the continuing accuracy of this instrument?

MR. R.G. NADEN

Yes, I neglected (I will probably remember a number of things I neglected to say) we do conduct, and are required to conduct, six stack surveys per year and submit these results to the Department. The real purpose of these stack surveys is to check the calibration and accuracy of this equipment. As it turns out, we actually run about 20 stack surveys each year; and in addition, the government runs stack surveys of their own to check our equipment.

MR. W.A. FLOOK

Using different equipment?

MR. R.G. NADEN

We don't run our own, we are running it through a contract lab.

MR. W.A. FLOOK

My second question concerns the liberation of the salt gases during the slating process from the liquid sulphur. This applies only to the slating process, or does it apply when you are pouring sulphur onto a heap as well?

MR. R.G. NADEN

When you pour it onto the block, the slow cooling tends to contain the gases in the sulphur, and you don't get this sudden release. I am saying sudden release. You could stand down-wind of it and not be affected. You could surely smell it, and you will have smelt the odour in the sulphur slating areas. This is what we are getting at and trying to remove.

MR. W.A. FLOOK

The third one, Mr. Naden, concerns B.O.D. measurement. I notice in your slide you indicated that you did one B.O.D. measurement, one 5 day B.O.D. per week. Do you have a backup measurement such as C.O.D. or total organic carbon such as you do on a daily basis?

MR. R.G. NADEN

Yes, this is the problem with B.O.D. We have a limit on B.O.D., but to run a B.O.D. sample takes five days, so you have to find other means of analyses that will correlate to a B.O.D. reading. C.O.D. is one that you have mentioned. Some of the carbon analyses are others. You've got to get something that you can do in fifteen or twenty minutes to give you the same indication, and these we have, and of course they are run daily.

MR. W.A. FLOOK

These you are doing. Thank you.

DR. W.R. TROST

Mr. Naden, I would like to compliment you on your very clear and well worked out presentation, thank you. You indicated to Dr. Smith that the life of the field would be finished somewhere in the 1980's.

MR. R.G. NADEN

I'm saying, going into decline - in other words, today you have enough deliverability from all your wells to keep the plant at capacity. The day comes where, in flowing all your wells, you don't have enough gas to fill the plant - that day comes in the early 1980's.

DR. W.R. TROST

Now what about the life of the plant? Is it tied in in some way?

MR. R.G. NADEN

The life of a plant? Some facilities are designed for a full life. With some pieces of equipment we are on our third or fourth piece already. I don't think you can make a general statement as to what is the life of a plant other than the sweet gas plant. I think a sweet gas plant would last the life of the field,

25 years without any problem. A sour gas plant would depend on your areas, your most corrosive areas, your treating plant, your sulphur plant, you just can't depend on these being designed for the life of the field.

DR. W.R. TROST

Now, I read in today's Albertan, I think it was,"'New Process to Remove Sulphur' Shell Canada Ltd. The new process called 'The Shell Claus Off Gas Treaty Process' has been successfully tested in Europe and is now available for commercial application. The Company said in the release Friday that virtually complete removal of the sulphur can be achieved". Did you refer to this process in your presentation?

MR. R.G. NADEN

Yes. This is the process that we are now evaluating for application in Waterton.

DR. W.R. TROST

And was my extract as I read it from the paper in correspondence, with what you actually believe to be the case?

MR. R.G. NADEN

It was correct. It was this process I was referring to that will cost in excess of $10 million.

DR. W.R. TROST

And with this process you feel that you can meet the projected guidelines of the Energy Resources Conservation Board?

MR. R.G. NADEN

Yes, that is correct.

DR. W.R. TROST

When you have your operations set up, when they are working in the way that you want them to work, they produce the kinds of results that you can describe most easily. What, though, is the role of accident in such a well worked out situation?

In a well worked out situation you know what your parameters are, and you know what your average results may be; but accidents can arise. Do you want to say anything about the role of accidents in these kinds of circumstances?

MR. R.G. NADEN

Yes. I think you are referring to incidents that result in plant upsets. Is this correct? When you consider the limitations of men and equipment you cannot prevent all incidents, you cannot prevent plant upsets; but if you consider the fact that the plant operates 24 hours a day, you cannot afford to have too many incidents before your performance is dropping below 99%. I was mentioning that our performance has been above 99% and I think we are having too many incidents. We are having too many plant operating problems, we have a new facility, and it's a very, very difficult job operating a complex like a gas processing plant. I think as our people have become more familiar and we have taken on an awful lot of new people with the expansion of the plant, their training is a continual thing. As they become more competent in their operation, you do get better. But you are talking about ninety-nine point something.

DR. W.R. TROST

Now, in this regard, we had earlier submissions from Mr. Baskin referring to training programs that could be jointly operated or worked out in co-operation with management and labourers. Would you like to say anything about that?

MR. R.G. NADEN

We carried out a very, very comprehensive training program before the start of the No. 2 plant. The training program extended for nearly eight months. Everyone went through it. It was an off shift type of training program, a classroom type training program. These are very difficult to put on; but you have to, I think, periodically at all plants go through this exercise; particularly before new plants are started up. It is very valuable to get some sort of training and competence into your operating, maintenance and staff people before facilities are put on strain. I think it is an absolute necessity.

DR. W.R. TROST

Mr. Naden, you made some mention about emission controls, techniques and also ground monitoring, and I think I understood you to say that you were using feedback from both of these in plant control. Did I understand correctly?

MR. R.G. NADEN

We are using telemetered feedback from our five air quality trailers. One is a radio telemetry so that we can move that trailer around. The other four are in fixed locations - these are reading back sulphur dioxide instantaneous sulphur dioxide, ground level concentrations, no feedback from the sulphation system. What was the other system you referred to?

DR. W.R. TROST

Emission control - when you are measuring the emission content itself.

MR. R.G. NADEN

This instrument is located right in the control room itself.

DR. W.R. TROST

Well then, is it feasible and practical to use ground monitoring as ambient standards as a plant control device?

MR. R.G. NADEN

I would think in 85% of the cases the ground level monitor is the plant control. When you have a plant located in the shadows of the mountains like Waterton is, your meteorological conditions are so important and have such a detrimental effect on good dispersion of gases that you end up running your plant off your air quality monitors, and here's a case where they are very slow in developing new ideas and new techniques. Now that we have got the five trailers operational, we find that we have so much more feedback than we used to have with just the two. With the two we used to have them manned 24 hours a day, just to get a feedback with someone with a portable radio. That had been going on for about six months.

DR. W.R. TROST

Now is there much inertia in a system of that sort?

MR. R.G. NADEN

In what way?

DR. W.R. TROST

By the time the ground monitor is detecting the substance, there may have already been a substantial amount released.

MR. R.G. NADEN

I think we are finding more of our readings are where you think everything is fine, and everything is fine. So you check through your operation, you can see your closest trailer is starting to make a climb. Now, what do I do? Well, you start checking your ground. Is there anything wrong? By that time maybe your second trailer has picked up an indication, yet your plant operation is normal. Now the big decision comes. When do I start to cut gas; because in reducing a plant, cutting flow on a plant the size of that; it can, in 90% of the cases, create more problems than it resolves. I think our whole performance attitude and our whole performance approach would be to the fine tuning, finding out just what areas we can change to affect the ground level monitoring. Stack top temperature is one. Can you increase your stack top temperature to provide better diffusion, more thermal rise, to reduce ground level concentration without moving it from trailer A to trailer B, or from trailer B to some place where there is no trailer.

DR. W.R. TROST

I would like to get you to elaborate on some of the effluent problems that you discussed. I am sure we all agree it is good news that the sulphur dust problem looks as if it is turning out well, but I understand that there is some likelihood that the friability of the slated materials increases after certain periods of time and then you might get, again, some dust. Is this a problem?

MR. R.G. NADEN

This has been a problem that's been concerning us ever since we started into the slating problem. We, ourselves, have not had slate stored in one pile for more than a year; but I know that some companies have had slate stored for about a year and a half; and to date, no problems. I think I am more concerned at the atmospheric temperature at which a slate may be formed, and then it goes through a couple of summers and a winter. Then, yes, there may be some problems, but it's still new enough, and in such early stages of development, we haven't been able to get good historical data on the strength of slates after a long period of storage.

DR. W.R. TROST

But so far it's not too bad?

MR. R.G. NADEN

No, so far it's not too bad. It's more dependent on the number of stages of handling more than anything else.

DR. W.R. TROST

Now, you described to us the tests that you were conducting to discover experimentally, and through research, the effect of certain emissions on plants. Have you got any results yet?

MR. R.G. NADEN

We have some results. The program has only been in effect three months - the first stage, the pot stage, really was a research type project to ensure that we had a good program design. From the initial results I think I can say, quite confidently, that we have selected a good program; and will get into the larger pot work. We probably will be conducting more pot work again next year. Yes, I think we have got something going; but results, it's like asking for the score in the hockey game after the first period. I don't know who is winning! The results, I can't, I'm not in a good position to be able to lay out some of the things I would like to lay out. Not only results but conclusions and recommendations. This is the stage; and, as we have mentioned to the people locally; when we do get some of our results, something that is meaningful; we are going to talk to them about them.

DR. W.R. TROST

Are you going to design an experiment to - when you design an experiment you often have a preconceived notion as to what your points of emphasis should be - is it sulphur dioxide that you consider to be your most sensitive emission?

MR. R.G. NADEN

We selected our plants from a sulphur dioxide sensitivity standpoint because this seems to be what the literature is full of, but I would like to get more knowledge than I can read about. In everything you read, it seems that you are doing the right thing. This is why I had mentioned we are now looking at the problem from the effects end. Let's start growing something and see what the effects are, and then try and determine what might be creating the effects.

DR. W.R. TROST

Now, it may be that the more difficult problems outside the plant may be different ones than inside the plant. Is that the case?

MR. R.G. NADEN

Plant - small "p" - are you talking about my growing plant or ...

DR. W.R. TROST

No, this plant may grow too. But no, it's the dead one.

MR. R.G. NADEN

I think we have a much better understanding of high concentrations of sulphur dioxide and hydrogen sulphide than we do low concentrations. Regulations have changed over the yearson hydrogen sulphide, for instance in the working atmosphere. I remember when I first started, you could work for eight hours in 20 ppm in hydrogen sulphide. Then it went to 15, now it's 10. We do, however, seem to understand the higher concentrations than, of course, we are trained to work in; and are able to work around those concentrations and prepare ourselves safely if they are exceeded. When, however, you get out into the areas surrounding the plant and the very, very low concentrations they are not only very difficult to detect, but you're trying to find out more, really what effects they have. This really is the purpose of the program.

DR. W.R. TROST

Are there other materials that you consider to be serious problems besides the major three, hydrogen sulphide, sulphur dioxide and sulphur?

MR. R.G. NADEN

We are not discounting any; and we are trying to keep an open mind on this one, because if we knew all the answers, we wouldn't be having any problems. No, there may be others.

DR. W.R. TROST

Do any products from the Claus Process itself give you concern?

MR. R.G. NADEN

No, they don't.

DR. W.R. TROST

I think at some stage you've mentioned that your production water and surface runoff water and so on were finally fed into the Drywood Creek. Is that right?

MR. R.G. NADEN

The north Drywood, yes. Not the produced water. The produced water is collected and trucked and re-injected into a producing formation. No surface handling of produced water.

DR. W.R. TROST

What did that production water ...

MR. R.G. NADEN

It's water of condensation primarily. It's not salt water.

DR. W.R. TROST

... and it's then returned directly to the underground ...

MR. R.G. NADEN

It's returned to a producing formation not in the Waterton Field.

DR. W.R. TROST

Then, most, or at least some of the other material, other effluent material from the plant would normally collect presumably in the surface runoff waters and so exit?

MR. R.G. NADEN

Every storage facility in the plant yard is diked. You are trying to prevent any discharge of any waste into a drain system, into a surface water drain system. In the event if something does, we have our drain systems all connected with the surface runoff system so that anything in the plant that is washed away with rainwater is collected into these surface water holding pits.

DR. W.R. TROST

They are held there, and is this where you apply your bioassay?

MR. R.G. NADEN

This water is tested primarily for pH, because they're down by the sulphur storage areas, so you could get the carry-through of sulphur dust into the runoff system. It's tested, and if necessary, treatment can take place right in those holding ponds; treatment with caustic, or treatment with whatever else may be required. You can also run Static Fish Bioassays on that water, but the Dynamic Fish Bioassay is on the waste water treating facility, the effluent, the process water effluent.

DR. W.R. TROST

Now, I know from one of your slides you are taking analyses in the Drywood presumably before and after the plant effluent goes in. What are the results of your analyses?

MR. R.G. NADEN

I have included sample results in my brief showing the results of all those analyses. I think the only one that was exceeded in that case was iron, and this was the result of some fairly severe corrosion in our cooling water system. The buildup in iron in our water was the result of this, which isn't abnormal in the plant. We, of course, have to resolve not only our corrosion problem but the increased iron in the effluent.

DR. W.R. TROST

Thank you very much, Mr. Naden.

Mr. G. Gainer summarized the Canadian Petroleum Association

Brief Presented in Calgary

BRIEF PREPARED

FOR THE

ALBERTA ENVIRONMENT CONSERVATION AUTHORITY

BY

MR. & MRS. JAMES D. TAYLOR

As people who derive their livelihood from agriculture, we realize and appreciate the importance of the petroleum industry. A highly mechanized agriculture depends upon this industry for its source of fuels, oils, greases, and chemicals. We also realize that this same industry depends a great deal on agriculture for the sale of many dollars worth of its products. We feel, that as a family living on a valuable farm property, within the pollution area connected with the operation of two Sulphur Plants, we have been paying much too dearly for the benefits from this industry. In the following statement I will try to illustrate and explain why we feel this way.

Before 1961, we were only occasionally affected by fumes. In 1961 development of the Shell Plant and gas wells took place south west of us. This is the direction from which prevailing winds blow over our property. From then on we have suffered in many ways and on many occasions.

Our greatest concern was and still is human health. Our family suffered the following symptoms which we related to the presence of fumes. Usually, the first symptoms noticed are red, itching burning eyes; a burning feeling in the nose, throat and lungs, followed by a sore throat and dry cough. Other symptoms are anaemia and severe nose bleeds. Our oldest son was hospitalized because of the nose bleeds. Severe sinusitis has been a recurring problem. Tests were done after sinus wash-outs and no bacteria could be cultured Other symptoms were severe headaches, dizziness, loss of sense of balance, ear problems, listlessness, extreme tiredness, and groginess; restless sleep and nightmares in the case of the children; swelling of nose and upper lip; nausea; bronchitis and pneumonia; pale greenish color of skin and difficulty breathing. There was one case of paralysis which was extensively investigated in a Calgary Hospital. These symptoms appeared more noticeably in some members of the family than in others. Also, fortunately, they did not all appear at the same time.

Our records show that we have repeatedly consulted doctors regarding these symptoms. Upon leaving the area for a while or if a change of wind direction occurred, symptoms were gradually relieved. At times, when some recovery was noticed, a recurrence of fumes seemed to make a second recovery more difficult.

I will now refer to symptoms we have noticed in our livestock. For various reasons we no longer raise pigs but it was one of our farm enterprises for quite a number of years. The most alarming symptom was bleeding noses, which on a few occasions coincided with our son's nose bleeds. In cattle the symptoms varied depending on the age and situation of the animals. In the case of feeders which were confined to the feed lot, loss of appetite, red and running eyes and going off feed were the main problems. Cattle on pasture also suffered running eyes. On several occasions it was noted that the herd on pasture would hurriedly leave their usual feeding area and head for another area usually on much higher ground.

With regard to vegetation, we have noticed some effects. It has been difficult to grow house plants. On vegetation out of doors we have seen whitish spots on the leaves. Later the damaged part of the leaf sometimes falls out leaving a hole. The leaves of a young birch tree lost some of their green color and turned a pale yellow color before the normal change to fall colors. The tree has been moved to Pincher Creek and appeared to be quite normal in color this year. Some garden and house plants appeared to have had something poured on their foliage. With regard to cereal crops, the yield to the best of our knowledge, has not been adversely affected.

We feel that there is excessive corrosion of our fence wire, machinery and all other articles made of those metals which are subject to corrosion. We have had opportunities to examine and compare our machinery with that from out of the pollution area and have seen a marked difference. There is a deep pitting in the affected surfaces.

There is also a very noticeable difference in the tarnishing of silverware. We have experienced this because we lived in Pincher Creek for nearly a year and many of our belongings are still there.

Undoubtedly, there is a great need for research. Perhaps greater laboratory facilities could be provided and a co-ordinated testing program undertaken. We know that some testing is being done. It is almost impossible for us to do any valuable research on our own because it is difficult to secure laboratory services, as well as the fact that we are not trained in this type of work. Furthermore, it is very costly. One sample of water that we had tested cost $63.00 plus the shipping charges.

We would suggest a revision of tolerance levels be made.

For the improvement and preservation of the environment of our area we would suggest there be a thorough investigation and solution to existing problems before any further expansion of present industries or beginning of new industries such as mining and smelting is undertaken.

Finally, I would like to add that we have not blamed everything on the sulphur industry. We have spent much time and effort in looking for other possible causes for our health problems as well as the problems noticed in our livestock and other farm operations.

Mr. & Mrs. James D. Taylor

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mrs. Taylor, one question about the timing of the health problem as mentioned. You indicate that before 1961 there didn't appear to be a problem, and subsequent to 1961 there was. Is the problem, now, in 1971, of the same intensity as it was when the plant first started up, or has it decreased?

MRS. J. TAYLOR

Perhaps it may not be the same, but we still have a problem - there was gas last night and we noticed the effects, and there was gas this morning too. There wasn't the strong smell, but we could feel the effects of it.

DR. S.B. SMITH

One other problem. As you know we are holding these hearings to attempt to get all the information possible given to us so that we can make recommendations to the government, and statements in our public prospectus. Do you think, or have there been meetings here with company officials, public meetings? Has the company held meetings on its own to try and explain what is going on?

MRS. J. TAYLOR

I don't know if they have held meetings as such, but we have spoken to quite a number of officials. They have come to our home.

DR. S.B. SMITH

No, I meant public meetings, something like this one where they call people in.

MRS. J. TAYLOR

There were in the earlier years, I understand; but I didn't attend them.

DR. S.B. SMITH

Thank you.

DR. W.R. TROST

Mrs. Taylor, I'll say this sooner or later. What's your family - daughter, sons?

MRS. J. TAYLOR

We have three boys, one is 13, one is 8, and one is 5.

DR. W.R.TROST

And they were then quite young at the time.

MRS. J. TAYLOR

Yes, the oldest one was two years old.

DR. W.R. TROST

Have you moved in the interim?

MRS. J. TAYLOR

We spent most of last year in Pincher Creek.

DR. W.R. TROST

Do you still run the farm?

MRS. J. TAYLOR

Oh, yes. This is how we make our living. We have to be out there a great deal of the time.

DR. W.R. TROST

The children then have in fact grown up from being quite young to now, just in their early teens.

MRS. J. TAYLOR

Yes, you are right.

DR. W.R. TROST

What is their health like now?

MRS. J. TAYLOR

Well, I noticed a paleness. They have had a lot of anaemia. They did improve last winter, and I think this could be checked with the doctors. I might add that my health, my anaemia also, improved last winter.

DR. W.R. TROST

And your husband?

MRS. J. TAYLOR

He has never been anaemic.

DR. W.R. TROST

Now, you said that you had also looked into other causes for these health problems.

Is there any other indication of any other kinds of things?

MRS. J. TAYLOR

Well, first of all we had propane, a propane cooking stove and a propane fridge. This was in the early years and we decided to change this, just in case the fumes from these appliances were bothering us. The other change that we made wasn't really a change, it was an addition. We thought the air might be too dry in the house, so we bought a humidifier. Those are two of the things we have done that I can think of at the moment.

DR. W.R. TROST

The doctors have diagnosed your problems. Have they suggested any other kind of a cause for these things?

MRS. J. TAYLOR

No, but we do have a letter from one of the doctors in the earlier years, and he definitely connected it to the air.

DR. W.R. TROST

Have your neighbors had similar difficulties?

MRS. J. TAYLOR

Yes. The night that I mentioned, one of the nights that my son had a very severe nose bleed, I know that three of the neighbours' children had bad nose bleeds.

DR. W.R. TROST

I believe that there has recently been some out of court settlement for difficulties in this particular part of the province. Were you one of the people who was engaged in that?

MRS. J. TAYLOR

Yes, we were.

DR. W.R. TROST

And, just again, to draw it into focus, have you had additional difficulties since that time?

MRS. J. TAYLOR

Yes, we have. The money does not solve the problem. No amount of money will.

DR. W.R. TROST

This is, in a way, a difficult kind of a problem to put money values on, but if there are to be returns of any sort to the person who suffers for these kinds of things, I suppose money is the way to do it, or is there some other way?

MRS. J. TAYLOR

This was never our objective, money itself was never what we had wanted. We wanted clean air, and we would like to be just left alone. With good clean air we can manage very well. We have a very good farm.

DR. W.R. TROST

I would like to put this question in two parts. Do you feel that the air has improved, the quality of the air has improved recently, in the last two years or so?

MRS. J. TAYLOR

It has changed, yes, it could have improved. It doesn't have the burning effect to the face quite as much. This is something we did notice for many years. There was a hot feeling on the skin, and this is not quite as common.

DR. W.R. TROST

Do you feel that it is possible to improve the air to a satisfactory level and still have the plants operating?

MRS. J. TAYLOR

We very much hope so.

DR. W.R. TROST

When you were looking into your problem, and your letter indicates that you have looked at it in a thoughtful way, did you get assistance in trying to define what the problem was from government agencies and from other groups and so on?

MRS. J. TAYLOR

When do you mean, over the last eleven years?

DR. W.R. TROST

Yes.

MRS. J. TAYLOR

Yes we did, through the group that was organized here. We went through every channel we could.

DR. W.R. TROST

Now, in the end, what is your basic recommendation in the face of this kind of problem?

MRS. J. TAYLOR

Well, my recommendations were as stated in the very last of this report. We hope we can live there and we hope that the air will be suitable for living. We are hauling our water from Pincher Creek, but we can't haul air.

DR. W.R. TROST

Right. You hope the problem can be worked out?

MRS. J. TAYLOR

Yes. We hope very much that the problem can be worked out and we can continue living on our property.

DR. W.R. TROST

Thank you very much.

MR. W.A. FLOOK

I'd like to ask just one question Mrs. Taylor. You use an expression "there wa gas again last night". I presume in your family that's how you refer to it wher this happens. What kind of odour do you notice. There are three main classes of odour that could be detected, one would smell like rotten eggs, one might smell like gasoline or petroleum products, or the other might be just a burning suffocating type of smell. Which is it that you notice?

MRS. J. TAYLOR

Well, last night, I would say that we noticed the type that you maybe associate with a cesspool or a rotten slough.

MR. W.A. FLOOK

A sort of rotten egg smell?

MRS. J. TAYLOR

Yes, probably.

Institut
Français
du
Pétrole
North
American
Office

A PRESENTATION TO THE ENVIRONMENT CONSERVATION AUTHORITY OF THE PROVINCE OF ALBERTA

ON THE SUBJECT OF

THE ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS IN ALBERTA

BY

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The Institute Francais du Petroleum brief reprinted here was presented in Pincher Creek, Red Deer and Whitecourt by J. W. Andrews.
Different versions of this brief may be found in the Edmonton and Calgary proceedings.

I - SUMMARY

The IFP-1 and IFP-2 processes can be used to alleviate the problem of Sulphur pollution in the Province of Alberta.

1. The IFP-1 process meets current guidelines of the Province of Alberta Energy Resources Conservation Board, giving as high as 99.3% overall Claus plant - IFP-1 plant sulphur recovery.

2. The IFP-2 process meets regulations similar to those proposed by the US Environmental Protection Agency, giving as high as 99.5% overall Claus plant - IFP-2 plant sulphur recovery.

3. Salable sulphur of 99.9% purity is produced as the end product of both IFP-1 and IFP-2 processes. There are no products under normal operating conditions which would contribute to either water pollution or terrestrial pollution.

4. Investment for an IFP-1 plant of 1450 LT/D capacity, meeting current ERCB guidelines, is $2,000,000. The total sum estimated by IFP required for the entire Province of Alberta is of the order of magnitude of $20,000,000. Operating costs for an IFP-1 process plant of 1400 LT/D capacity are 0.25 ct per thousand standard cubic feet of gas treated.

5. If requirements are made more stringent , e.g. similar to those of the US EPA, the IFP-2 process rather than the IFP-1 process will be required to meet regulations on almost all plants. In this case, investment for an IFP-2 plant of 1400 LT/D capacity would be $4,000,000. The total sum estimated by IFP for the entire Province of Alberta is of the order of magnitude of 140,000,000. Operating costs for an IFP-2 plant of 1400 LT/D capacity are 0.56 ct per thousand cubic feet of gas treated.

6. If the IFP-1 process is installed to meet current ERCB guidelines, and these guidelines are subsequently made more stringent, the owner of the IFP-1 plant is not penalized if he subsequently installs the IFP-2 or similar high-recovery process to meet the tighter requirements. The recovery achieved in the IFP-1 unit lowers the investment necessary for the IFP-2 or similar high-recovery unit. Overall investment for stepwise construction is just about the same as it would be were the IFP-2 or other high-recovery plant built initially.

7. Six full scale IFP-1 plants are in operation in Canada and Japan. Three more are being constructed : in the US, Japan, and the USSR. One full scale IFP-2 plant is being started up in Japan. Thus both IFP-1 and IFP-2 processes are industrially proven.

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II - INTRODUCTION

In discussing any process for the recovery of gaseous sulphur compounds to prevent atmospheric pollution in the Province of Alberta, it appears that several criteria must be satisfied:

1 - The process must not solve the problem of atmospheric pollution by creating one of water or terrestrial pollution.

2 - It should produce an end product which is salable under competitive conditions in the world market.

3 - It should ensure that investment made to meet sulphur recovery levels recommended at any given time will not be sacrificed if and when plant must subsequently be modified for higher recoveries.

4 - It should be as economical as possible, both in initial investment and in operating costs.

5 - It should be an already proven process.

Institut Français du Pétrole (IFP) wish to present evidence in this brief that two of its processes, hereinafter referred to as IFP-1 and IFP-2, satisfy these conditions. It should be noted, however, that the level of investment necessary is different for the two processes.

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III - IFP-1 PROCESS DESCRIPTION

The IFP-1 process is an extension of the Claus process itself, currently used in plants for incinerating hydrogen sulphide from sour gas, and catalytically reacting the sulphur dioxide produced with hydrogen sulphide to yield elemental sulphur. The Claus reaction as carried out in the gaseous phase in Claus plants is limited by fundamental physico-chemical considerations to about 97% recovery. In the IFP-1 process, the Claus reaction is conducted in the liquid phase using a proprietary catalyst and solvent, and recovery can be as high as 95%, giving an overall recovery, when used in series with a traditional Claus plant, of 99.3%.

III - IFP-1 PROCESS DESCRIPTION (continued)

As shown in Figure 1, the process is very simple and easy to operate. Tail gas from the Claus plant is injected into the bottom of the IFP reactor tower while the catalyst solution is injected at the top. The reaction is carried out above the melting point of sulphur, and molten sulphur accumulates in the bottom of the tower, where it is drawn off to storage. The catalyst solution is continuously recycled from the bottom to the top of the reactor. Cleaned gases leave the top of the tower and are burned in an incinerator. The only piece of rotating machinery is the solvent - circulating pump. Because corrosion is no problem, the whole plant is built of ordinary structural steel.

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IV - IFP-2 PROCESS DESCRIPTION

As shown in Figure 2, the IFP-2 process uses two sections : an ammonia scrubbing section, and a reaction section. Incinerated tail gas is scrubbed with a water solution of ammonia, and the cleaned gases are vented up the stack. The ammonia brine,containing sulphur salts, is evaporated and reduced to yield ammonia and sulphur dioxide. This stream is treated with hydrogen sulphide in an IFP reactor tower as in the IFP-1 process, producing high purity sulphur, while the ammonia is taken off from the top of the tower and recycled to the scrubber.

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V - END PRODUCT CHARACTERISTICS

The end product of both the IFP-1 and the IFP-2 processes is sulphur of 99.9% purity or higher, bright yellow in color, containing typically 30 parts per million of mineral impurities, and 200 parts per million of organic impurities. Sulphur of this grade is suitable for use in the chemical industry, and commands as high a price as sulphur produced in the Claus plant itself.

There are no other products which must be stockpiled, and in normal operation there is no discharge of pollutants to streams or other bodies of water.

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VI - RECOVERY LEVELS, PLANT INVESTMENT AND OPERATING COSTS

The IFP-1 process brings equivalent sulphur dioxide levels down from the 15,000 - 20,000 parts per million normally vented from Claus plants, to about 1800 ppm at the stack mouth of the IFP-1 unit. This is equivalent to an overall Claus plant - IFP-1 plant sulphur recovery of 99.3% , a level which complies with the minimum sulphur recovery efficiency guideline laid down in the Energy Resources Conservation Board informational letter 71-29.

The IFP-2 process reduces sulphur dioxide levels at the stack mouth typically to 500 ppm, but to as low as 200 ppm if required. These concentrations are equivalent, respectively, to 99.8% and more than 99.9% sulphur recovery. The latter figure meets the most stringent regulations proposed by any county or municipal authority in the U.S.

If the IFP-1 process is installed to meet current ERCB guidelines, and requirements subsequently be made more stringent, the owner of an IFP-1 plant is not penalized economically when he must subsequently install the IFP-2 or other high-sulphur-recovery process to meet the tighter requirements. The recovery achieved in the IFP-1 unit lowers the investment necessary for the IFP-2 or other high-recovery unit. Overall investment for stepwise construction is just about the same as it would be were the IFP-2 or other high-recovery plant built initially.

The tables which follows present typical investment and operating costs for IFP-1 and IFP-2 plants.

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VII - CONCLUSION

It has been estimated by IFP that a gross capital expenditure of the order of magnitude of $20,000,000 is necessary to have a small number of applicable plants within the Province of Alberta meet existing guidelines of the ERCB, when the IFP-1 process is utilized to meet these guidelines. A gross capital outlay of the order of magnitude of $140,000,000 is estimated to be needed to bring stack effluents of almost all the gas plants within the entire Province down to levels similar to those proposed by the US Environmental Protection Agency, when using the IFP-2 process to meet these lower limits.

TABLE I

TYPICAL ECONOMICS

ALBERTA CLAUS PLANT	1400 LT/D SULFUR PRODUCTION 96.5 WT % RECOVERY 0.66 MOL % $H_2S + SO_2$ RECOVERY

	IFP-1	IFP-2
OVERALL RECOVERY (CLAUS + IFP)	98.0%	99.5%
INVESTMENT ($ MILLION)	2.0	4.0
OPERATING COSTS ($/DAY)		
UTILITIES	30.	403.
CATALYST + CHEMICALS	347.	4.
LABOR	--	394.
TOTAL	377.	801.
PER 1000 STD CU FT	= 0.26¢	= 0.56¢

(AND AFFILIATE)	LOCATION	CLAUS PLANT	START-UP	IN IFP UNIT
NIPPON PETROLEUM REFINING (CALTEX)	NEGISHI, JAPAN	REFINERY, 3 STAGES, 300 T/DAY	SEPTEMBER 71	85
IDEMITSU OIL	HIMEGI, JAPAN	REFINERY, 3 STAGES, 250 T/DAY	APRIL 72	75
SHOWA OIL (SHELL)	KAWASAKI, JAPAN	REFINERY, 3 STAGES, 50 T/DAY	APRIL 72	85
CHEVRON STANDARD (CHEVRON RESEARCH)	NEVIS, ALBERTA	GAS PLANT, 3 STAGES, 250 T/DAY	JUNE 72	65
KYOKUTOH OIL (MOBIL)	CHIBA, JAPAN	REFINERY, 3 STAGES, 200 T/DAY	AUGUST 72	85
PHILLIPS	BORGER, TEXAS	REFINERY, 1 STAGE, 45 T/DAY	OCTOBER 72	92
MITSUBISHI OIL (GETTY)	MIZUSHIMA, JAPAN	REFINERY, 3 STAGES, 200 T/DAY	END OF 72	85
MINISTRY OF GAS	OREMBURG, USSR	GAS PLANT, 3 STAGES, 2400 T/DAY	END OF 73	75

IFP-2 PLANT

UBE TOWN GAS	UBE, JAPAN	GAS PLANT, 12 T/DAY	OCTOBER 72	200 PPM SO_2 IN STACK GAS

IFP-1 PROCESS

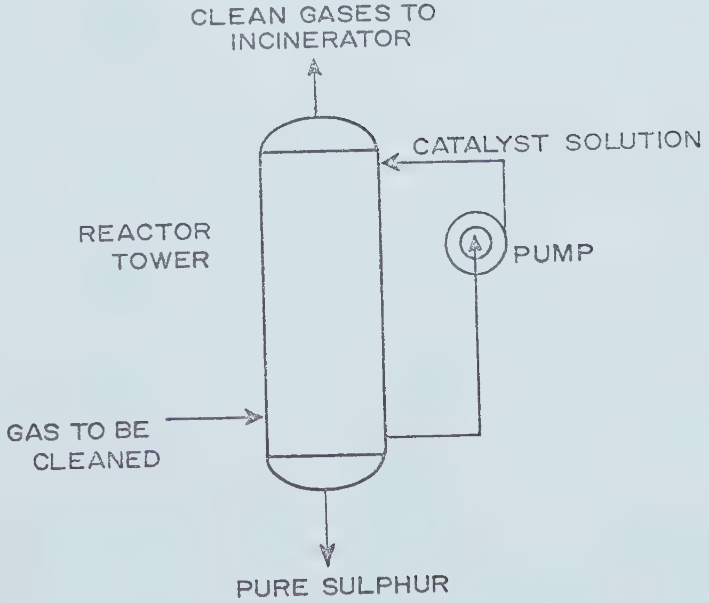

FIGURE 1

IFP-2 PROCESS

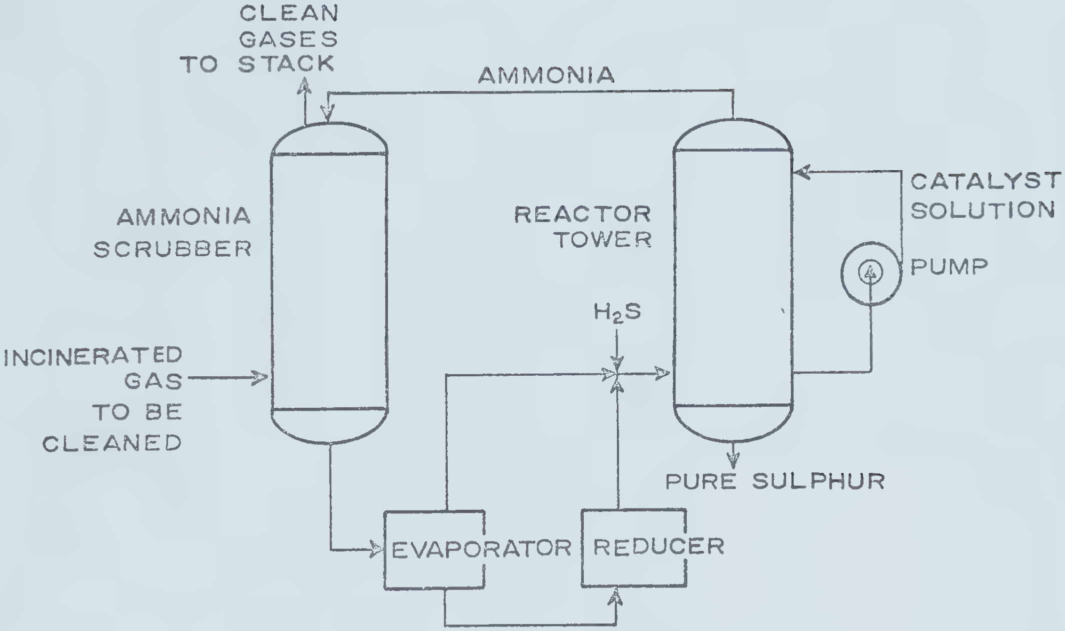

FIGURE 2

QUESTIONING BY THE AUTHORITY

MR. W.A. FLOOK

Mr. Andrews, you mention a potential recovery of 99.3% or 99.5% of sulphur with two processes, IFP-1 (99.3%) and IFP-2(99.5%). Does this mean that this process is capable, in fact, of taking care of carbon disulphide and carbonyl sulphide as well?

MR. J. ANDREWS

In the second case, sir - IFP-2.

MR. W.A. FLOOK

In the case of IFP-1, how do you cope with these compounds?

MR. J. ANDREWS

The process itself does not touch those compounds.

MR. W.A. FLOOK

In other words, they are just as the Claus Process produces them.

MR. J. ANDREWS

-- unless they are taken out in another manner before they reach our system.

MR. W.A. FLOOK

Such as in addition to the Claus Process?

MR. J. ANDREWS

Yes, sir.

MR. W.A. FLOOK

Which would be a further addition to the cost of your plant, in effect.

MR. J. ANDREWS

Yes, sir, that's correct.

DR. W.R. TROST

Mr. Andrews, how reliable are these data?

MR. J. ANDREWS

Which, sir?

DR. W.R. TROST

The ones you have shown us.

MR. J. ANDREWS

The data that we have shown for the comparative processing comes from two sources. The first one is plants which we built in Japan; in Russia; one plant in Canada; and one plant which is starting to be built, or is in the engineering stages, in the United States. Now that is as far as IFP-1 is concerned. IFP-2 is being installed now in Japan on a gas plant not of this nature, but a synthetic gas plant concerned with tar residual. We are using cross data from that plant for this purpose.

DR. W.R. TROST

If I have understood you, IFP-2 is still on the drawing board stage so its data are determined by laboratory or pilot plant methods. Is that so?

MR. J. ANDREWS

IFP-2 will be on stream on October 10th.

DR. W.R. TROST

It will be on stream.

MR. J. ANDREWS

Yes, sir.

DR. W.R. TROST

In a week?

MR. J. ANDREWS

Yes, that's right, sir.

DR. W.R. TROST

In Japan?

MR. J. ANDREWS

Yes, in Japan.

DR. W.R. TROST

But IFP-1 has been installed in industrial systems, again in Japan, and is working, has a record of performance?

MR. J. ANDREWS

Yes, sir.

DR. W.R. TROST

So your data for IFP-1 comes from an industrial installation, whereas IFP-2 comes from the other plant or some other.

MR. J. ANDREWS

IFP-2 is built, but it is not in operation.

DR. W.R. TROST

So you haven't any operational data?

MR. J. ANDREWS

Yes, that's right. The cost data we do have. I'm sorry, I thought that was your question.

DR. W.R. TROST

So in fact you've got cost data, industrial cost data, for both; but you have industrial operational data for only the one.

MR. J. ANDREWS

Yes, that's correct.

DR. W.R. TROST

You have an order in for that sort of plant construction in Alberta?

MR. J. ANDREWS

Which one, sir?

DR. W.R. TROST

For the IFP-1.

MR. J. ANDREWS

In Alberta?

DR. W.R. TROST

Yes. I'm sorry. You listed places where you were installing these units.

MR. J. ANDREWS

May I show one more slide please. This is the list of the plants which we have license design, and which ones are on stream. The first one is the plant we have in Japan, which is IFP-2. So, at the top we show Nippon Petroleum which is an affiliate of Caltex in Japan, Itomitsu Oil in Japan, Shell Oil in Kewasaki, Japan, Chevron up in Nevis, Kiukuto which is Mobile. Phillips in Borger, Texas is not on stream yet. That should be on stream probably around January. Mitsubishi will be into 1972. That is not on stream yet, probably in December. The Ministry of Gas in Russia, there are three separate plants there, tending to a Claus unit capacity of 2400 tons per day. I might say, also, that Mitsubishi 1 and Mitsubishi 2, are also going to be published. It's not announced as yet, and this is the IFP-2 plan.

DR. W.R. TROST

Do you want to elaborate a little bit on your last column, percent recovery in IFP unit?

MR. J. ANDREWS

Yes, sir. This is very interesting because we can design up to about 95% recovery through our process. It's not always necessary to do that. For example, you'll see there's one at 65%, and that was all that was requested from that licensee. So, the higher the number on the end does not necessarily mean the most expensive plan, but tends to be that way. There are other factors which hav to do with what the concentration of the H_2S and SO_2 are in the feed gas as well. The highest conversion we show there is Phillips at Borger, 92% and we have designed one, it's not official yet, at 93%.

DR. W.R. TROST

Now in these cases, in which the recovery of sulphur in the IFP unit varies by substantial amounts, what is the total recovery of sulphur in those plants?

MR. J. ANDREWS

A very good question. I don't have those data available here. In the case of Japan, I believe they have a total emission spec which they must follow, and therefore the material balances around the whole refinery. They say - "oh, right this is where we will work on this plant in order to make the balance come out right". In Chevron Standard, I would refer you to Chevron Standard. In Phillips Borger, Texas, for those if you don't mind, it's a little technical, they have a two stage Claus system with a rather high amount of H_2S and SO_2 coming from it, and therefore, we are able to go up higher to 92%. Ministry of Gas in Russia - God knows what sets their specifications. I don't.

DR. W.R. TROST

Now in these cases, again returning to the economics; comment, if you don't mind, on how the cost of the plant, of the installation, compares with the values recovered.

MR. J. ANDREWS

Well, unfortunately, not very well. Let me explain. When you put in a Claus unit to start with and recover 95%, 94% to 97% sulphur, I am not sure what the economics look in that area. I have never done them, but you are recovering an awful lot of sulphur. If the sulphur market is good, I wouldn't be a bit surprised if you make a lot of money, if the sulphur market is very good. On the other hand, when you are talking about going from 95% to 99% or 97% to 99%, overall recovery, you are talking about not very much sulphur production, and you are talking still about an appreciable investment, as you have seen on one of the previous slides. I doubt very much whether you could ever pay it out, under any circumstances.

DR. W.R. TROST

But if the IFP unit were installed in such a way, if I have understood your data correctly in the last column, it can be so installed as to be a major sulphur recoverer rather than a minor one.

MR. J. ANDREWS

Yes, sir, on the remaining H_2S plus SO_2.

DR. W.R. TROST

These are the plants that you have experience with and therefore, may I ask, when you do install an IFP-1 unit in a situation where it's a major sulphur recoverer, how did the economics come out there? Does it pay its way?

MR. J. ANDREWS

No, sir. I think perhaps I can help a bit. It would come closer to paying its way in a case like this where the recovery through a two stage Claus system might only be 85% of that nature. Now we are recovering not only 3% or 4%, but we are recovering the difference between 85% and 97%. I still doubt it would be economical, but it would be closer to it.

DR. W.R. TROST

Any further questions, Dr. Smith - Mr. Flook? Thank you very much, Mr. Andrews.

BRIEF

THE ENVIRONMENTAL IMPACT OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS IN ALBERTA

Pincher Creek, Alberta
October 2, 1972

Submitted by: Pincher Creek
Industrial Pollution Committee

Presented by: B. McRae

Our involvement with the problems associated with the sulphur extraction industry began originally with the drilling of gas wells, through to the installation and production of two sulphur extraction plants, and still exists.

We began by filing individual complaints to company representatives followed by complaints to government authorities. The ensuing government investigation stated no problem existed and as a last resort a group of landowners filed a damage suit against two oil companies which after more than seven years was settled out of court.

As a group of people who have been affected by pollution from sulphur extraction plants, who have experienced the frustration of inadequate legislation compounded by people in responsible positions without the authority and courage to enforce what legislation existed, and who finally resorted to court action in an attempt to get a serious problem recognized and resolved we would like to present the following brief as a result of our experiences.

a. Present tolerance levels are misleading in that other substances or gases may be present and the combination of chemicals could be very toxic in an amount much lower than the tolerance level allowed for each chemical.

b. Since pollution of the environment is such a serious problem, new legislation regarding such offences should become a matter of criminal law and should be applicable to individuals as well as companies. Workmen, who through carelessness or negligence, create a condition which contributes to pollution, should be liable to a charge as much as a motorist is. Over the years many serious incidents have resulted when a wrong valve has been turned, a vessel or tank allowed to overflow or waste dumped in a careless manner in a convenient spot.

As well, persons in authority who accept incomplete, inaccurate, or falsified records pertaining to control of pollution should be liable to a charge.

c. It must be considered negligence when companies overload plant facilities for any reason and create conditions which endanger the safety of workmen as well as the general public.

d. Shell has placed test plots on farm lands but not one was placed on the property of the 15 landowners who sued the two plants for damages incurred as a result of pollutants. We feel this will give an inaccurate picture of the pollution problem as some of the more affected spots have been bypassed and legislation based on this type of result will not protect everyone. One of the points on which the law suit was settled granted the companies the right to discharge effluents not in breach of valid orders, approvals or regulations of any Governmental authority as are at such time applicable to such processing or operation. Thus every piece of property in the area must be considered in drafting regulations and the companies are responsible for the safety of every person including the fifteen families in the law suit if they choose to remain on their farms in the future.

e. We would recommend that the government set up a research project similar in scope to that set up by Shell with the firm of Farm and Ranch Management Consultants, who have stated some damage was evident but no official results have been released. There is a lack of research facilities available to individuals whose cooperation and first hand observation could contribute to the collection of data if scientific opinions could be obtained on samples collected and sent in. Samples are accepted by the above firm but results and information to date have been unobtainable.

f. There is still a severe health problem in humans and livestock in the area at times. Complaints have been made to the companies with no result other than statements to the effect that the problem will be looked into and a man sent into the area. The companies must be made responsible for the problems when they are created, not for looking into them afterwards.

g. Repairing of machinery is very difficult as well; a result of excessive oxidation of metal due to pollution from the plants. Rapid deterioration of fence wire and yellowing and aging of certain types of paint are also still a problem.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. McRae, in your first point a) you suggest that the combination of chemicals or any other combination of chemicals might be more toxic than any one chemical. Have you had advice or hard information on this? I might go on to say that this is known for certain classes of chemicals, that have what is called a synergistic action. As they complement each other and make each other's action harder.

MR. B. McRAE

Personally, I haven't. We have been told that certain marcaptans and things of this nature could be causing the problem, but as far as a chemist or someone actually giving us hard and fast information on that topic, I don't think we have any information on that.

DR. S.B. SMITH

Where you suggest that legislation should become a matter involving the criminal code rather than with civil law, are you suggesting here that the citizens have a proprietary right in their own air, land, water; the type of things which are normally considered crown resources?

MR. B. McRAE

I believe what we were mostly concerned with here was the fact that at different times we had been aware of loads of salt water that were to be injected into some of the wells, or into the one well that they inject into, had been dumped onto the road instead of being injected into the well. This is why we stated that we thought that with individuals who had the responsiblity to look after things like this it should be a point of criminal law instead of civil case.

DR. W.R. TROST

Mr. McRae, would you tell me what the membership and the source of establishing the Pincher Creek Industrial Research Pollution Committee were?

MR. B. McRAE

There were originally seventeen families involved in this. It was later reduced to fifteen. Our source of information mostly came through our lawyer in Edmonton, who is a chemical engineer as well as a lawyer.

DR. W.R. TROST

So, the Pincher Creek Industrial Pollution Committee is then a committee of fifteen families in the Pincher Creek area?

MR. B. McRAE

It was originally the committee that was set up that actually sued the two oil companies; composed of fifteen families.

DR. W.R. TROST

For the purpose of that act did you have to constitute yourself as a legal entity?

MR. B. McRAE

Yes. I believe that the Committee was first formed in 1963.

DR. W.R. TROST

And in that period of time you first of all drew attention to your complaints. There was some enquiry under government auspices, then legal action, and over several years of time a settlement. Was the settlement reached with the Pincher Creek Industrial Research Pollution Committee itself?

MR. B. McRAE

Yes, it was. It's a little difficult to differentiate, but the lawyer dealt with the committee as a committee, and yet there were personal settlements.

DR. W.R. TROST

Your brief contains the substance of an important element of our enquiry, and therefore I would like to go into it in considerable detail. First, is there anything further that you would like to relate to us, in respect of the experience of the several years of the past, that has preceded the present situation?

MR. B. MCRAE

I think, possibly, I wouldn't want to enlarge, myself. Mrs. McRae's brief will be a partial duplication with probably more specifics mentioned.

DR. W.R. TROST

You talk about "inadequate legislation, compounded by people in responsible positions without the authority and courage to enforce what legislation existed." Do you want to elaborate on that sentence?

MR. B. MCRAE

When we first started to enquire with the government into how we could try to have our problem resolved, we found that there was some legislation available that could in effect close a plant down, if they were interfering with the right of us to live on our property and enjoy our property. Not very long later, this legislation, through the Provincial Government, was rescinded and by an Order in Council, this legislation was no longer available to us to close a plant as a result of their interfering with our right to live and enjoy our property. We had different interviews with men such as Dr. Donovan Ross. He insisted that there was no problem. We just felt these people lacked the courage to act upon the legislation available, and that if they would have given us some co-operation and taken the attitude that we really had a problem, there would have been legislation enacted far sooner that would have enabled us to have this thing alleviated much sooner than it was.

DR. W.R. TROST

Are you suggesting that your problem was not in fact taken seriously?

MR. B. MCRAE

I'm not suggesting it, I'm saying that it definitely wasn't.

DR. W.R. TROST

Now, after the onset of your initiative, did you seek and obtain co-operation from government agencies?

MR. B. MCRAE

We never did get what we considered co-operation from the government agencies. Right to the end of the law suit, they still seemed to have the opinion that we were quite neurotic in the Pincher Creek area and that really we weren't to be taken seriously. I think that I could honestly say that we had very little co-operation from the Provincial Government. Even our lawyer found it very difficult to get specific information from data that were filed or government files. It was made available to us in a way because, they said, "There it is, you can look through it", but there was more than a person could go through in the time that the lawyer had.

DR. W.R. TROST

So, it was left to the initiative of your group to bring about whatever enquiries or investigations or developments which were needed to prosecute your own case.

MR. B. MCRAE

It was totally left to the group. We had no encouragement from the Government whatsoever.

DR. W.R. TROST

Did you have discouragement?

MR. B. MCRAE

Very definitely.

DR. W.R. TROST

In what sense?

MR. B. MCRAE

Lack of co-operation mainly, and unavailability of documents that we knew they had and that they wouldn't make available as such.

DR. W.R. TROST

You are suggesting that the offence should be a matter of criminal law and should be applicable to individuals as well as companies. Do you want to elaborate on that?

MR. B. MCRAE

What we were aware of was, that on different occasions material was dumped on roadways and allowed to spill into ditches and eventually get into the natural waterways. This we felt should be a criminal offence by the individual. The company has very little control over it.

DR. W.R. TROST

You are suggesting that if an employee of the company were to, through accident or misadventure, create an environmental damage that the individual employee should be subject to the full penalty of the law?

MR. B. MCRAE

We felt that individuals should also be subject, as a motorist is when he is involved in a misdemeanor.

DR. W.R. TROST

But if there is a heavy penalty, that might develop from that accident or misdemeanor, and that individual were unable to bear it, then what would your suggestion be?

MR. B. MCRAE

I suppose that in, like in cases where even in the laws that we now have, where an individual is actually carrying on duties, under the auspices of a company, that the company could to some extent be brought into the case and possibly prosecuted too.

DR. W.R. TROST

So, you feel that there may be two cases of misdemeanors, those of individuals and those of employers.

MR. B. MCRAE

Yes.

DR. W.R. TROST

Does that apply as well to "As well, persons in authority who accept incomplete, inaccurate or falsified records pertaining to control of pollution should be liable to a charge."?

MR. B. MCRAE

We felt that this should definitely be a joint prosecution because a company would also be aware of falsification of records.

DR. W.R. TROST

Have you any basis for suggesting that there has been such an event in the past?

MR. B. MCRAE

Yes. Instances where readings were higher, I'm just not too sure I should answer that. But there were tetralog readings that we were convinced were, if not falsified, they were not put on the record. By not being there, they actually created a false impression.

DR. W.R. TROST

You state that the test plots on the farm lands did not include a location on the property of the fifteen landowners who were involved in the court case. Is that the case still today?

MR. B. MCRAE

Yes, it is.

DR. W.R. TROST

Have you any reason why that might be so?

MR. B. MCRAE

I haven't. I was quite surprised that they didn't put some of these plots on some of the land that they had apparently, as a result of settling out of court, admitted a certain amount of guilt. I would have thought that that would have been the first places they would have put these plots and these trailers where they knew there was a problem.

DR. W.R. TROST

Were any of the individuals approached?

MR. B. MCRAE

I honestly couldn't say whether they were or not.

DR. W.R. TROST

One of the points on which the law suit was settled granted the companies the right to discharge effluents not in breach of valid orders, approvals, etc. I'm not quite sure what you mean to imply by that.

MR. B. MCRAE

This was a part of the legal document that our lawyer drew up. The companies were permitted to operate to discharge effluents, not in breach of valid orders, or limits that the government had set up; if they operated above these limits, this again constituted grounds for action or damage. There seemed to be a misunderstanding that after we had signed the release that we had no more claim against the oil company. We have, if they operate over standards that your board set, I presume your board has that authority now, that they were again liable to damage settlements.

DR. W.R. TROST

There were no specific effluents that were mentioned in this?

MR. B. MCRAE

I don't believe there was any specific effluent mentioned.

DR. W.R. TROST

Then you continue that every piece of property in the area must be considered in drafting regulations, and the companies are responsible for the safety of every person including the fifteen families in the lawsuit. Was that part of the settlement?

MR. B. MCRAE

Yes, it was further to this that if the companies operated over their authority, the families that had received settlement, had just as much right as anyone else to again bring an action.

DR. W.R. TROST

Perhaps you would like to elaborate a little bit on what changes that have occurred in the period of time prior to the actions leading to the court case, and the situation as it now obtains.

MR. B. MCRAE

Mr. Naden stated they erected a new stack which was somewhere in the vicinity of 200 feet high or 250 feet higher than their old stack. The effect that this had was that, instead of dissipating the effluents into the atmosphere; with the inversions that we have, it seemed to just relocate them. The last year we've had more problems in our particular operation than we did before. I believe that the stack didn't actually dissipate any more of the effluents. With the type of air currents that we have in this country, the smoke or anything be brought down within a mile of the plant at times. Other times it will go into the atmosphere.

DR. W.R. TROST

You say you have had problems again. What kind of problems?

MR. B. MCRAE

Mostly health problems in our family. We also had to stop raising hogs. One animal was killed as a result of a gas concentration in a certain area, a couple of years ago. It had complete embolism of the lungs and the veterinarian considered we send it into the Provincial Lab. They could find no bacteria and no infectious organisms.

DR. W.R. TROST

Has there been any plant damage?

MR. B. MCRAE

We've noticed these white spots, too, on some of our trees and such, which would indicate an SO_2 concentration, but as far as productivity is concerned we suspect it in certain areas of our alfalfa.

DR.W.R. TROST

Do you feel that the guidelines that have been established by the Energy Resources Conservation Board and by the Department of the Environment will move towards handling the problem, or are you still concerned with the situation?

MR. B. MCRAE

We are still concerned with the situation because when you consider the amount of effluents that are put into the atmosphere, 248 tons a day; even if you are down to 1% of this, it's still a considerable amount of effluent.

DR. W.R. TROST

Do you want to elaborate on the recommendation in paragraph (e)?

MR. B. MCRAE

We felt that this was a good type of approach that Shell has taken to the problem, but we felt that we weren't getting any results from it personally or individually We thought that it should be carried on by a neutral body, to guarantee it.

DR. W.R. TROST

Have you any connection with the research program that Shell is conducting?

MR. B. MCRAE

Not other than apparently one of the fellows at our place wanting to put some mice or, I don't know if chickens were involved, but I think there was some mice involved.

DR. W.R. TROST

Would you cooperate with it?

MR. B. MCRAE

Yes, we would.

DR. W.R. TROST

You claimed that there is still a severe health problem in humans and livestock in the area at times. Do you want to elaborate a little bit on the health problem in humans that apparently still exists?

MR. B. MCRAE

I don't think there is anything new that has developed in humans other than what we have already experienced. Mrs. Taylor touched on the main problems that we have. We don't have as much problem with anaemia, but chest pains and shortness of breath and feeling of being tired and listless is what we mainly noticed. We still get severe burning of nose and throat.

DR. W.R. TROST

This is air-carried material in the atmosphere is it? And you can smell it?

MR. B. MCRAE

Yes.

DR. W.R. TROST

It's intermittent is it? It depends on the wind, the direction of the wind?

MR. B. MCRAE

It's intermittent, and is directly correlated with the wind.

DR. W.R. TROST

Does it depend a little bit on whether it's a chinook, an inversion or not?

MR. B. MCRAE

Yes, although even a very hard wind seems to concentrate it more. We have had difficulties in a very hard wind.

DR. W.R. TROST

Do you know what particular chemical substance that it might be?

MR. B. MCRAE

No, I don't. I, we suspect at times SO_2 because of the smell.

DR. W.R. TROST

Have your agents had air analyses done when the thing was there?

MR. B. MCRAE

No, we have no equipment or anything to capture this.

DR. W.R. TROST

Now, in your last paragraph you refer to corrosion problems on metals. Is that still going on?

MR. B. MCRAE

Very definitely. We have different instances of where excessive oxidation has taken place because on new equipment, if there is a place that wears, oxidation sets in very rapidly and it makes it extremely difficult to make adjustments on threads, to such a point that you would break a rod rather than be able to make the adjustment. The implement dealers in Pincher Creek have stated also that machinery coming from our area is very definitely harder to work on, and have a higher repair problem to them because of the rust.

DR. W.R. TROST

Do you mean the threads freeze?

MR. B. MCRAE

Absolutely, to where you can't move them in any way.

DR. W.R. TROST

What about wire?

MR. B. MCRAE

It will pit and eventually rust right through. Wire is a little difficult because there have been fences in the area that have been in for years, and have naturally oxidized, but we have land out of the pollution area; and there is no comparison to fixing it in the area.

DR. W.R. TROST

Is there anything else you want to add to your deposition?

MR. B. MCRAE

I don't believe there is, except that Bob suggested that oxidation wasn't too much of a problem, at the plant; but I noticed that on their sulphur collection apparatus slides that the appartus was very definitely rusted to quite an extent. Thank you, I think that was all.

DR. W.R. TROST

Thanks very much, Mr. McRae. I would like to call on Mr. H.R. Pharis, from the Municipal District of Pincher Creek.

BRIEF TO:

ALBERTA ENVIRONMENT CONSERVATION AUTHORITY

OCTOBER 2, 1972

Submitted by: H. R. Pharis
Municipal District of
Pincher Creek # 9

We appreciate this opportunity to make a few remarks, of a general nature, which pertain to environmental problems we have experienced and have been cause for great concern of Council since gas processing and sulphur industry began operating in this area nearly 15 years ago.

It was in the late 1950's that the Council began receiving complaints of illness of residents, reports of unusual effects on livestock and vegetation. Extreme investigation was made by the Dept. of Health and the oil companies involved, but their reports indicated that there were not sufficient quantities of hydrogen sulfide or sulphur dioxide in the atmosphere to cause the symptoms being reported.

However, the Council is concerned that several residents in this area have suffered a great deal of hardship since the gas industry began operating in this area - perhaps substances in emission not sufficiently monitored or not tested for at all contributed to these hardships.

It all became evident that attempts to measure and control emissions were complicated by atmospheric conditions peculiar to this area -- eg. inversion layers which caused emissions to be trapped in the lower atmosphere.

This points out the need for extensive research in analysis of emissions from processing plants, a study of changes in atmospheric conditions, which greatly affect the levels of concentration of harmful emissions into the atmosphere.

The Council has been concerned about stream pollution and feel that a very close monitoring and policing system be concentrated and maintained to ensure that our streams do not become polluted from industrial waste.

We hope these remarks will help to demonstrate the Municipal District Council's concern for the need of extensive government involvement in solving the problems that stem from industrial development.

Respectfully submitted,

Municipal District of Pincher Creek No. 9

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. Pharis, have you some specific examples of stream pollution where the productivity of the stream is affected or where fish were actually killed?

MR. H.R. PHARIS

Fishermen who have fished the area tell me that there were, but I do know of instances where people caught fish in the Drywood River, a stream that was renowned for good fishing a couple of years ago, and found them with a very distasteful flavour.

MR. W.A. FLOOK

Mr. Pharis, are you suggesting the need for extensive research in the analysis of emissions from processing plants, particularly as they're affected by atmospheric conditions? Who are you suggesting might do this research?

MR. H.R. PHARIS

Well, perhaps in the last paragraph we suggested that the Provincial Government must be the authority in anything like this. Eight years ago the health unit for this area took an active interest in pollution because at that time that was considered part of the health unit's business. Through Dr. Adler, the Director of the Health Unit, we suggested setting up guinea pig stations. The Health Unit offered to oversee it, but it was quite briskly turned down, and eventually anything to do with it was removed from the local authorities.
It seems to me from a Council point-of-view the sad part of this whole thing was the breakdown of communications between the local people, the Shell plant and the Provincial Government. As a Council, we had interviews with the Shell plant, the Department of Health and Dr. Ross, the Minister of Health, and even with Premier Manning; and everyone was concerned, everyone was making an effort to solve the problem. Premier Manning, at that time, set up an impartial committee to really look into the situation. I believe it was chaired by Dr. Seamens of California. This committee would have been received very favourably by the local people, but as it turned out they proceeded to destroy the credibility in a most amazing

fashion. They made a few quick trips through the area. Many of the people concerned didn't have a chance to talk to them at all. As a Council we met with them. Another way that they destroyed their credibility was that they had time to be the guests of the Shell plant for an evening. I am no way finding fault with Shell in this case, but yet they didn't have time to hear the complaints of the people, and that's where they should have gone. That was where the case really broke down, where the local residents lost all confidence in Provincial Government and perhaps even the Municipal Government. They began to talk about taking action to the courts.

I would think that if we learn nothing else from this it would be that when we have hearings of this type and when people are investigating, that right at the grass roots is where they must spend much time. The people would have been only too glad to have called meetings and really given them their side of it. This hearing such as we are having here is not new. I was through one before and many people were in the old courthouse, hours of testifying from local doctors, and one thing and another. As a local government we tried not to lose sight of the fact that we are the local Government for the Shell people, as well as the residents. We attempted to do the proper thing for a local government to do, but certainly it was unfortunate the way the mistrust was built up through lack of competence of everyone concerned.

MR. W.A. FLOOK

Would you like perhaps to express an opinion as to where you think the whole thing is falling down? Is it that the standards are not realistic or they are not adequate? Is it that the measurement devices are not properly deployed, or not sufficiently effective, or is it that you are not being told the truth?

MR. H.R. PHARIS

I wouldn't want to say that I was never told the truth from any of the parties concerned, because I don't know. I had no reason to doubt that it was just from my own experience when I drive through that country, perhaps you wouldn't be thinking about pollution at all, when you hit a place out here by the underpass, suddenly there was something in the air. It didn't make me sick, but it would burn my nose and throat. Yet there were people in the Department of Health who would occasionally come through here, and they would say that there was never anything that they could smell. They weren't aware of it. I think one person from the Department went back and said he would gladly move his family into any of that area.

Perhaps the controls were not stringent enough when the plants were set up. Perhaps with the more stringent controls, perhaps this goes a long way now, but certainly we have atmospheric and air conditions that are somewhat different from many localities. In the area over the plant, particularly on winter days, it goes up and up, and then flattens right out. It's just like a roof over it, it will lie there for hours, then it floats off and down it goes.

MR. W.A. FLOOK

Is it fair to say it was a little bit of each?

MR. H.R. PHARIS

Well, I don't know about a little bit of each. I wouldn't suggest for a minute that Shell plant had any idea that they were going to get into this when they put the plant there. My experience with the officials was that they were quite well pleased with the type of plant they were putting in and they expected it to be a model plant. Of course, human beings being what they were, they were most reluctant to admit that it wasn't.

DR. W.R. TROST

Mr. Pharis, can you tell me what area the Municipal District of Pincher Creek comprises?

MR. H.R. PHARIS

The Municipal District of Pincher Creek covers the area from Waterton Park North to about 24 miles north of Pincher Creek, and from the Peigan Indian Reserve at Brocket west to the Forestry Reserve along the mountains.

DR. W.R. TROST

How many sulphur extraction plants are there in your Municipal District?

MR. H.R. PHARIS

There are two in the M.D. of Pincher Creek and one directly west of it.

DR. W.R. TROST

Is there any regular relationship between the gas plants and the Municipality? Do you have anything official to do with it?

MR. H.R. PHARIS

We don't have a formal committee set up, but Shell Coil and Gulf both have. If there's anything to talk about they are more than willing to come and talk to the Council about it.

DR. W.R. TROST

There is a good working relationship between you and them.

MR. H.R. PHARIS

As far as communications, they'll talk to us anytime.

DR. W.R. TROST

I'd like you to elaborate a little bit on any changes that you think may or may not have occurred now as against a few years ago. Has the situation changed in a noticeable way or not?

MR. H.R. PHARIS

I don't know. I am under the impression personally, that perhaps it isn't as bad as it was a few years ago, but persons who live in the area might not agree with that. Partly, I would base that opinion from talking to people who work in the plants and to the employees. I think they realize enough, perhaps a greater sense of responsibility has been passed down to the employees, that this has to be looked after. From conversations I've had with some employees at the plant and what was well brought out by the person who spoke for Shell Oil here, is that when something starts to go wrong an individual must make a decision. Perhaps a few years ago, a decision was to let it go, save the plant; whereas perhaps now they have an awareness of what's going to happen if they start flaring a lot, or letting it go, or what might happen if they didn't.

DR. W.R. TROST

I would assume from your submission that you, in a general way, support at least some of the points that were put forward by Mr. McRae on behalf of the Pincher Creek Industrial Research Pollution Committee; particularly the suggestion that a way forward now would be through research into the problem, with attention to be paid to the solutions that would come out of that research.

MR. H.R. PHARIS

I would agree with that.

DR. W.R. TROST

Did you think that the research programs that were being described this afternoon were useful ones?

MR. H.R. PHARIS

Yes. I might say too, that the Shell officials, when they were setting this up, came to the Council and laid the whole program before the Municipal Council for comment, and kept us informed on it; and we endorsed it. I think this is certainly a step in the right direction.

DR. W.R. TROST

Is your proposal for research in addition to that, or would you like to have that done under different auspices?

MR. H.R. PHARIS

No. This is being conducted by a firm of consultants that Shell has hired. If these are credible people, certainly their findings should be of value to the Shell Company and to the people living here, and to the Municipal Council too.

DR. W.R. TROST

Do you feel that you would have access to the results of that research in a direct way from the Company?

MR. H.R. PHARIS

We were assured by the Consulting Firm and Shell Oil Company that the Municipal Council would have complete access to the results.

DR. W.R. TROST

Do you think the Company would be receptive to suggestions that you might make as to programs they might do research on?

MR. H.R. PHARIS

Yes, I believe they would.

DR. W.R. TROST

I would now like to call on Mr. R.A.A. Thompson to speak to us on behalf of Gulf Oil Canada Limited.

The Environmental Effects of the Operation of Sulphur Extraction Plants in Alberta

Presented by: R. A. A. Thomson
Gulf Oil Canada Ltd.

Gulf Oil Canada Limited supports the brief presented by the C.P.A., copies of which have been submitted to the Environment Conservation Authority and which are also available for anyone who wants one here today. In addition to this C.P.A. brief we submit the following which relates specifically to our operations in the Pincher Creek Area.

Gulf Oil Canada Limited owns and operates the gas plant located 18 miles S.W. of town on the east side of Highway #6 and the Pincher Creek gas field. We also partly own and operate the Lookout Butte field and compressor station located east of Waterton Park.

The Pincher Creek Plant is one of the older plants in Alberta and was the source of some of the first gas delivered to Trans-Canada Pipe Lines Limited. Over the years, throughputs have declined from a peak sales volume of 137.5 MMCFD in 1960 to the present maximum sales volume of 66 MMCFD. Inasmuch as the Gulf Pincher Creek Gas Plant was the first sulphur extraction plant to be operated in Alberta with a daily capacity of several hundreds of tons, it represented a pioneer effort in the Sour Gas Processing Industry. In recognition of possible environmental strains which could result from our operation, and in the absence of any regulatory guidelines to assist us, we sought the assistance of other sulphur producing industries (refineries, smelters) and retained leading consultants in the design of sulphur recovery and waste disposal facilities.

The resulting severe design and operating restrictions to which we subjected our plant in 1958, have subsequently been proven to approach present day standards, such that under the now reduced plant throughput volumes, we adequately meet the demands of the environmentally sensitive regulations of the 1970's.

In spite of the declining nature of this operation and the economic restrictions imposed by this situation, we have consistently upgraded our sulphur plant operation in the interests of optimum resource utilization and environmental protection. We are pleased with the performance of this pioneer plant but we are not, however, pleased to the point of complacency, and engineering work is proceeding on modifications to converter bed configurations, burner design and tail end cooling to maintain and hopefully to improve present recoveries. We have faith in present recovery numbers because there is very precise agreement between the three methods of calculation available to us - stack emission continuous measurement, conventional material balance calculations and periodic stack surveys.

We maintain a network of air purity monitoring stations as a check on the effectiveness with which our rather small emission is dispersed. We have one continuous monitor which measures levels of SO_2 and H_2S in the atmosphere continuously and also records wind direction and velocity. This trailer is checked daily by our technical staff. There are also 44 exposure cylinders in the area of the plant and 6 exposure cylinders in the Lookout Butte area which give a measure of total sulphation. This data is analyzed, evaluated and presented to the Department of the Environment every month. To define further the nature of dispersion in this area we also conducted a plume survey this spring. Through the Federal

Department of Energy, Mines and Resources we arranged for a helicopter borne instrument backed up by a mobile ground level instrument to directly measure the path of our sulphur stack plume. The full report of this survey will be sent to the E.R.C.B., the Provincial Department of the Environment and to Environment Canada.

This plant has automatic and manual facilities to flare gas in the event of emergency or plant upset. Flared gas in 1972 was maintained at 0.04% of the inlet volume total, well below the provincial government's stipulated limit of 0.5%. The small amounts of flared gas are burnt in a special "smokeless" flare tip which uses steam to ensure proper mixing and combustion. We also comment that our key operating personnel are long-service employees who have worked in this plant since start-up and are, by virtue of their great experience, competent men who reduce upsets to the minimum. Here, too, we continually strive for improvement in the area of training programmes and upgrading of equipment and systems.

We are equally concerned in the area of waste water disposal. All produced water and plant process water effluent streams are contained in a closed system and injected by means of high pressure pumps into the gas producing formation. We have two disposal wells which are drilled and completed to depths in excess of 13,000 feet. Modifications to provide surge capacity in this system in the event of equipment failure are nearing completion and our policy and practice is to reduce plant throughput in the event of water disposal problems. All surface run-off from the plant area is drained into a series of retention ponds. Water in these ponds is routinely analyzed for contaminants and released only when the water is of a quality acceptable to the Department of the Environment. This release, which is at a controlled rate, is to the Drywood River. We conducted a thorough survey this past summer to establish that there is no underground leakage of these ponds. The work involved drilling water wells in the area down-slope from the ponds and sampling and analyzing the water in the wells. The work was conducted by an independent consultant--Materials Testing Laboratories.

With the present depressed state of the sulphur market we have a substantial stockpile of this material on the plant site - approximately 120,000 long tons. Adjacent to the "block", there is a problem caused by windblown sulphur which lowers the pH of the soil in the immediate area. We monitor this dustfall using eight measuring devices and report the data to the Department of the Environment. We also, in cooperation with the Provincial Department of Agriculture, are correcting the soil pH by the addition of lime in carefully measured amounts and then planting a mixture of winter wheat, grasses and clover. In concert with other sulphur producers, we are attempting to move all sulphur produced from the medium to small plants (such as Pincher Creek), in the liquid form, but the complete conversion to this program is limited by rail transportation constraints and economic conditions in the market place.

A rigorous and sophisticated schedule of checking field gathering lines is in force. The conventional "line walking" is supplemented by the use of gas detectors and probes. This programme is extended into the plant and supplemented by ultrasonic measurement of piping and vessels and x-raying of welds. These measures are designed to prevent damage and injury to personnel and to prevent release of process fluids to the atmosphere or the soil. All wellsites are equipped with either permanent or portable flare stacks with pilots and ignitors to ensure that no unburned gas is released to the atmosphere. All flare pits have been eliminated and all liquids are held in closed systems where they cannot contaminate the soil.

We show a continuing and top priority concern for the safety and welfare of our employees. These men are thoroughly trained in all aspects of safety and industrial hygiene and the training continues through weekly safety meetings which all employees must attend and are paid to attend. Contract personnel are also required to attend these meetings and do so at Gulf's expense. In addition to the traditional concerns for the normal hazards of this industry we have an on-going program to measure and prevent hearing damage resulting from high noise levels. All employees receive "audiogram" tests to determine if ear damage is occurring and ear protection of several types is provided and its use is mandatory. Buildings containing noisy machinery are posted at all doorways with warnings of the noise levels. The record of accident prevention in this plant speaks for the effectiveness of this programme. We even have a vehicle operator programme of instruction and testing which supplements legislated requirements. In fact, we have a relationship with a number of government agencies in the area of the safety and health of our employees which we feel is mutually beneficial and in every case we strive to exceed legislated requirements. Some of these agencies are the Workmen's Compensation Board, the Department of Health, the Boiler's Branch, the Electrical Protection Branch and the Energy Resources Conservation Board.

We consciously strive to be good neighbours by reacting immediately to complaints. We cooperate with the M.D. in the area of snow ploughing and particularly last winter our efforts were appreciated. We have attempted, with the full cooperation of the Matthew Halton School staff to explain our operation to their students. We outlined a balanced factual picture of our operation and were gratified by the open minded acceptance of our presentation.

In conclusion we submit that we accept, without reservation, our full corporate responsibility for the preservation of our environment and the safety and health of our employees and neighbours. We also believe that, through our economic impact on this community and our attempts to be good neighbours, we are being good, concerned and participating members of society - both at the corporate and at the individual level.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. Thompson, how long have you been Superintendent at the plant?

MR. R.A.A. THOMPSON

Since November 1st of last year, sir.

DR. S.B. SMITH

Have you been involved in answering complaints, or have you received any yourself while you have been in this position?

MR. R.A.A. THOMPSON

I have not personally answered the telephone; but I have been here while the calls have come in. In some cases, have dealt with them, and I've listened to delegated dealings with them.

DR. S.B. SMITH

Do you think these complaints are real? Are the symptoms that they describe real?

MR. R.A.A. THOMPSON

The complaints that I specifically am aware of in my personal experience did not describe physical bodily impairment. They described odours, and I certainly believe them.

DR. S.B. SMITH

Is it true that you haven't had personal contact with the kinds of symptoms described to us earlier this evening?

MR. R.A.A. THOMPSON

That is true, sir.

MR. W.A. FLOOK

Your plant is now operating at approximately half capacity, half its design capacity?

MR. R.A.A. THOMPSON

Yes, it's likely less than half. You can define the plant in terms of inlet or sales. It's a semantical exercise, but in general, yes.

MR. W.A. FLOOK

In doing this, installations that were put in in 1958 are now adequate to meet present day standards?

MR. R.A.A. THOMPSON

Referring specifically to sulphur plants, our Pincher Creek Gas Plant has in fact three sulphur plants, only one of which we operate at this time. That one is operating at a volume which approximates quite closely to its full design conditions.

MR. W.A. FLOOK

That single Claus unit was always maintaining the efficiency that it is demonstrating today? It is running at its full capacity now?

MR. R.A.A. THOMPSON

It is running at essentially a full capacity for that one unit.

MR. W.A. FLOOK

Is it a fact that you can indeed improve the environmental performance of a plant by reducing its through-put?

MR. R.A.A. THOMPSON

That again is a question that I must sound a little evasive about. Associated with the decline and through-puts at our Pincher Creek operation is a fairly prejudicial change in the ratio of hydrogen sulphide to carbon dioxide in the acid gases to which some reference was made earlier today, and this is a difficult thing to live with.

MR. W.A. FLOOK

You wouldn't generalize that just by reducing through-put, in improving the performance of a plant by trying to increase its sulphur recovery, that one way of doing it might be to reduce the through-put. Another way of doing it might be to install additional equipment?

MR. R.A.A. THOMPSON

Yes. Conversely, since these plants are very particular in their characteristics, it could be that by increasing the through-put you might under some circumstances increase the recovery efficiency.

MR. W.A. FLOOK

You indicated that your stack emission continuous measurement was checked by conventional material balance calculation and periodic stack surveys. Part of your material balance calculations were indeed these same stack emission continuous measurements?

MR. R.A.A. THOMPSON

No, sir.

MR. W.A. FLOOK

You have another method of measuring the effluents that are lost in your stack for the purpose of a material balance?

MR. R.A.A. THOMPSON

Yes. The material balance specifically ignores what vanishes off the stack merely arriving at that by difference, and concentrates on the measurement of the liquid sulphur that runs into the production pits.

MR. W.A. FLOOK

The periodic stack surveys are done by an alternative method as well?

MR. R.A.A. THOMPSON

Yes. One is done by an outside consultant and one is normally done by our own research and development people.

MR. W.A. FLOOK

You indicate that process water is contained in a closed system and injected by means of high pressure pumps into gas producing formations. How high a pressure?

MR. R.A.A. THOMPSON

We are limited to 2,000 pounds.

MR. W.A. FLOOK

At the well head?

MR. R.A.A. THOMPSON

On the surface casing the system operates at about 1800 pounds per square inch gauge.

MR. W.A. FLOOK

You are not apprehensive about fracturing the formation at these pressures?

MR. R.A.A. THOMPSON

Not in the least.

DR. W.R. TROST

Why has the plant output been reduced by so much?

MR. R.A.A. THOMPSON

It's a question of reservoir draw-down. The gas isn't in the field any more.

DR. W.R. TROST

It has no connection with the plant itself?

MR. R.A.A. THOMPSON

No, sir.

DR. W.R. TROST

The old plant is operating well enough today to meet today's guidelines. Did you add new technology to it in any way?

MR. R.A.A. THOMPSON

The plant has been extensively modified and upgraded over the years. New developments have been incorporated.

DR. W.R. TROST

You, in fact, have improved performance over the years?

MR. R.A.A. THOMPSON

Yes.

DR. W.R. TROST

You talk about "rather small emission is dispersed". How small?

MR. R.A.A. THOMPSON

With the plant running at present day maximum through-put, the maximum stack emission would be something in the order of 8 long tons of sulphur dioxide per day.

DR. W.R. TROST

Do you have say other plant effluents that you consider critical besides sulphur dioxide?

MR. R.A.A. THOMPSON

We have no routine effluents that we consider critical; but a great deal of the work that we undertake, the precautions that we take, are designed to prevent the release of a number of other things into the atmosphere.

DR. W.R. TROST

Do you know what your water effluent is and what effect it has on the Drywood?

MR. R.A.A. THOMPSON

We know very precisely what it is. It's surface run-off. We know what it is in terms of volume. We know what it is in terms of concentration of various contaminants, if you will. We know what it is in terms of B.O.D. and this sort of thing. As far as what it does to the Drywood River, this has to be a sort of an assessment type of thing. We sample routinely upstream and down. We are of the opinion that we have no significant bearing on the Drywood River as such because of the relatively small volume of this water that flows into it. It's controlled normally at something like 20,000 gallons per day, which sounds like a lot of water, but as related to the flow in this river, it's a fairly inconsequential addition.

DR. W.R. TROST

Do you want to elaborate on flaring in the event of emergency or plant upset?

MR. R.A.A. THOMPSON

Any processing facility has built into it certain safety features; and, in general, those employed by Gulf in this Pincher Creek Gas Plant involve the piping through either manual or automatic over-pressure devices, for example, into an enclosed flare system, which is run to a 150-foot flare stack with a steam atomizing arrangement on the top of it. All emergency releases of gas, from whatever stage in the process they may be in,are piped into this closed system and disposed of in this manner. Through training and experience we attempt to keep these volumes to an absolute minimum, but upsets can and do happen. This is the safest manner in which to handle this particular eventuality.

DR. W.R. TROST

Does this amount to something like sort of short circuit connections to the flare, so that if you have trouble in the plant you've got a direct release to it?

MR. R.A.A. THOMPSON

Yes, sir.

DR. W.R. TROST

What kind of emergency situations might give rise to this need?

MR. R.A.A. THOMPSON

The power failure is probably the single, most common cause of this.

DR. W.R. TROST

Do you run comparable plant control systems either from stack emission data or from ambient air data,as were described earlier by Shell?

MR. R.A.A. THOMPSON

Yes, however we have not at this point in time, either telemetered or in any other way automated the transference of information from the one trailer back to the control room. That is still handled on a human type basis. Continuous stack monitoring chart is right in the sulphur plant control room, and it reacts very rapidly. There is a very small time lag, and the operator is well aware of an incipient problem with plenty of time to correct it.

DR. W.R. TROST

On a stack emission basis?

MR. R.A.A. THOMPSON

Yes.

DR. W.R. TROST

You indicate that this program of moving liquid sulphur is done in concert with other sulphur producers. Do you want to elaborate on that particularly in view of the comments that were made about moving sulphur in the slated form?

MR. R.A.A. THOMPSON

In general the advantage of moving sulphur in its liquid form is that you eliminate a very large number of intermediate steps in the handling of the material. It can be pumped directly from the production pits into the railcar, or the truck, or whatever the transportation mechanism might be, and in so doing there is zero dust. The whole thing is conducted in a liquid phase. The two main advantages are the ease with which it can be conducted and the cleanliness of the operation.

DR. W.R. TROST

There are no vapours?

MR. R.A.A. THOMPSON

There are vapours if liquid, molten sulphur is dumped onto the ground for example, or an open pit. Normally the production pit is enclosed with only a very small vent to atmosphere, and the railcar or truck is also closed.

DR. W.R. TROST

Are there any hydrogen sulphide fumes given off by these liquid sulphurs?

MR. R.A.A. THOMPSON

Yes, I can't give you quantitative numbers, but liquid sulphur does dissolve a certain amount of hydrogen sulphide.

DR. W.R. TROST

Is that apt to be emitted as it cools, or vice versa? Does the solubility increase?

MR. R.A.A. THOMPSON

I believe that the solubility increases with temperature; as the sulphur cools some H_2S is released, but some is trapped within the block. If you pour it in a large block for example, the smaller amount of hydrogen sulphide that is trapped in there is essentially trapped forever, until you go to use the block at which time the little bit that's left will be released.

DR. W.R. TROST

When you move the liquid sulphur you have to keep it molten?

MR. R.A.A. THOMPSON

Yes, sir.

DR. W.R. TROST

Under the present market conditions, are you moving liquid sulphur?

MR. R.A.A. THOMPSON

Yes.

DR. W.R. TROST

Are you also stock piling?

MR. R.A.A. THOMPSON

We are stock piling a little bit. The problem is one of scheduling railcars which have a limited capacity. Your trying to balance the arrival of those things is beyond our control. It is a very difficult thing to balance it so that it comes out at the end of each week, that exactly the last ton of liquid sulphur you make goes into a railcar. We can't do it.

DR. W.R. TROST

But when you now stock pile, you now stock pile in block, rather than in slated form.

MR. R.A.A. THOMPSON

That is correct.

DR. W.R. TROST

You were describing the training program that you have in respect of your employees. Are all employees exposed to this program that relates to all apsects of safety and industrial hygiene?

MR. R.A.A. THOMPSON

Clerical employees, probably not; but all operating, maintenance, supervisory and engineering personnel, yes.

DR. W.R. TROST

Does the Union co-operate with you, or is it inovlved in any way in this training program?

MR. R.A.A. THOMPSON

There is full co-operation with the Union that we associate with.

DR. W.R. TROST

You say that the record of accident prevention in this plant speaks for the effectiveness of this program. What is the record?

MR. R.A.A. THOMPSON

The record is that in the last six years there have been perhaps two lost-time accidents in the Gulf Pincher Creek Operation.

DR. W.R. TROST

You say that you co-operate with the Municipal District? Do you want to elaborate on that?

MR. R.A.A. THOMPSON

We deal with the councillor that represents the area in which we operate. We realized that we could get a whole lot more done than just by going our separate ways. We have a rotary plow which can plow where a number of other machines cannot go, and if roads became seriously plugged we would phone Mr. Stucky. This is the sort of exercise that we conducted, a mutual back-scratching program.

DR. W.R. TROST

Do the two companies co-operate with each other? Are there joint programs, or is there any program of co-operation between the companies?

MR. R.A.A. THOMPSON

Since my arrival here we have opened up the channels of communication very satisfactorily. It has included exchanges of technical information, particularly on sulphur plant operations. We have initiated this discussion on a number of different topics.

DR. W.R. TROST

Has there been a combined study of the stack emissions from the two plants, and how they would be dispersed over the countryside jointly?

MR. R.A.A. THOMPSON

Technically, no, sir.

DR. W.R. TROST

Now, in respect of emissions into the Drywood Creek, since both companies use that, is there a joint program of any sort, or any co-operation, mutual consultation, joint control in respect of the use of that Creek?

MR. R.A.A. THOMPSON

No, sir, other than that that is there automatically, if you wish, through the Department of the Environment's Water Pollution Control people.

DR. W.R. TROST

Is there joint consultation or an exchange of information, or a forming up of a mutual attitude, so that the total effects of the two plants together on the environment are looked at routinely?

MR. R.A.A. THOMPSON

As the field representative of my company, I would like to back away from that, sir.

MR. G. GAINER

Mr. Chairman, on the matter of joint studies, Shell Canada and Gulf prepared maps of the total sulphation, as measured by our monitoring cylinders from inception, in the case of our plant, in 1957, and some four years later for Shell. This program is still going on. And as you are aware, these data are required to be supplied to the Department of the Environment within the month following the period for which the observation was taken. We exchanged these readily with Shell Canada. Shell supplied them to us. These are both hand-drawn and also drawn quite without bias by the off-set computer. When the data from the Department of the Environment arrives we supplement with these data. This often forms a good check, because we can go ahead and draw the contours based on the measurements that we have made. We can plug in the others and we can see validly how these other data work with it.

DR. W.R. TROST

In the research proposal and program that was outlined earlier today, by Shell, is there an input from Gulf on that research program?

MR. R.A.A. THOMPSON

Yes. At this point in time, no; but as I understand this there has been discussion between our two companies along the lines that Gulf's plant operating data be made available to the consultant who is conducting the study.

ENVIRONMENT CONSERVATION AUTHORITY BRIEF

Submitted by: Mrs. Gordon McRae

We are presenting this brief as a family who have experienced the effects of pollution from sulphur plants and gas wells and while we are no longer affected very much by fumes we hope that information from our experiences will help someone else.

Our first exposure to fumes occurred in the winter of 1957 and continued until the fall of 1964 when we moved to P.C. spending about two-thirds of the time in town and one-third on the farm. This was an unsatisfactory arrangement and in May 1967 we moved to a farm in the Beaver Mines area, west of P.C. but have moved the house to our present location. Most of the land is being used for pasture and the cattle are trailed back to Beaver Mines for part of the winter and spring and actually spend less than half a year in the area affected.

We have chosen to live out of the area because of the tremendous difference it makes to our health. It is common knowledge that we were involved in a court action against Shell and Gulf and there are some points I wish to make clear. We have the right to live in the area on the same location if we choose to. We are protected by the same regulations as any other resident in the area or in Alberta for that matter. We have the right to sue again if we feel regulations as set down by a government authority are not adhered to. We choose to live away from the area because we feel that up to the present time there is still a problem in the area, existing pollution legislation to enforce regulations or a reluctance to do so. Although there has been a general improvement there continues to be a series of incidents and upsets, along with clean-up operations resulting in a great deal of flaring. Wind and weather conditions add greatly to the problem. None of our six children have wanted to return to live on the property or take it over because of the fume problem, thus it becomes an economic and management problem as well.

We find that all members of the family still have symptoms of burning of nose, eyes, throat and tongue, soreness of chest with difficult breathing, indigestion and lethargy, when in the area if fumes are present. These symptoms are less severe than when there was constant exposure and disappear when we leave the area. The problem with hearing due to allergy, conjunctivites with hemorrhage and eye irritation, lethargy and severe stomachaches with gasiness have not recurred for any reason since leaving the area nor did they occur prior to exposure to fumes. As well the problem with wakefulness and nightmares is almost non-existent.

There ia an effect on vegetation and we particularly notice the large and increasing numbers of willows in low areas and coulees which appear to be dead. In comparing vegetation from two areas we notice a whitening of alfalfa leaves in the area affected. Where we presently live I have not seen leaves of such plants as sunflower, zinna, nasturium beans, potatoes and rhubarb with dead, papery light colored spots fallen out giving the leaf a ragged appearance. Nor have I seen young poplar growth dead with brown curled leaves having black edges or patches. This is common in the area particularly close to the Shell plant. At times in early summer the tender growth on oats and plants which freeze easily such as beans, potatoes and vines would show blackening of the edges of the leaves similar to frost damage when there had not been frost or even cool temperatures. We have been told by people who have flown over the area that there is a decided cone-shaped area beginning near the mountains and funnelling out eastward toward the Waterton River that is a different color in the summer believed due to the number of dead or dying trees in the area.

A great deal of time is lost due to the inconvenience caused by the rusting of machinery. The pitting of shiny surfaces, the rusting of moving parts, nuts and bolts makes preparing to operate, and maintaining or repairing a machine, very time consuming during a busy time. Damage to the paint causes greater depreciation on trade-ins or sales. Fence wire deteriorates rapidly due to pitting particularly in the area of the barb for when tightened the wire snaps. In comparing wire out of the area believed to be more than sixty years old with some fifteen to twenty years old the fault was found to be puted through in spots while the older wire was rusty and slightly pitted.

Visible effects on cattle include irritation of eyes, nosebleed, poor appetite in feed-lot cattle, slow growth in grass cattle and breathing problems. Pigs are very sensitive to fumes and baby pigs were born dead or died shortly thereafter from no other apparent reason. The family dog appeared lethargic and unwell at the same time the children were affected most.

In connection with monitoring equipment it would appear that accurate air sampling is impossible to obtain over such a large area. Quoting a February/1969 letter from the National Research Council of Canada,

> "We have often measured variations amounting to four times between locations situated not more than half a mile apart". The sampling boxes set on posts around the country are very unsatisfactory as:
>
> 1. they require a constant volume of air containing sulfur compounds for a definite period of time before they show a recording.
> 2. the readings are based on an average of a month's accumulation and may have actually occurred in a few instances during the period, and were originally designed and tested for measurement under calm conditions.

From the data compiled for our case it could be shown that on troublesome dates as verified by individual records and complaints filed in company records, air sampling records showed readings had been picked up on some monitoring devices in the area but nearly always well below the amount allowed. In nearly every instance conditions had been abnormal due to plant breakdown, overproduction, plant malfunction, excessive flaring or well-site or pipeline trouble.

With these points in mind we would like to recommend that:

1. the tolerance level limits for down-wind areas be lowered and that prevailing weather conditions and type of terrain be a factor in setting these limits and,
2. that legislation pertaining to air sampling concentrate on the control and limiting of effluents discharge at the very source, namely the stacks and flares and that a very accurate method of measurement of all effluents at these sources be required. We also recommend that industry be made responsible in some way for their periods of abnormal production, due to any reason when this creates severe pollution conditions.

Respectfully submitted
Mrs. Gordon McRae

CASE HISTORIES OF EFFECT ON HUMANS AND ANIMALS

First Child:

- 7½ years when first exposed in 1957. Allergy symptoms were most severe and the first reaction was large swelled patches on skin which we checked with Dr. and got antihistamine for. General depression, irritablity weepiness, head-ache, some severe stomach-aches and nightmare. Sleeplessness and restlessness at night. A poor appetite for breakfast and later developed rash, hives and itchiness as allergy symptoms. Earache and deafness caused by swelling of tubes to ears due to allergy. Dr. prescribed antihistamine nasal spray. Some discomfort from full feeling in ears regularly. Some eye irritation, burning of nose throat and eyes.

  These symptoms as associated with fumes when the child left the area cleared up. The skin allergy symptoms and the deafness problem have never occurred since. Flaring at wells and unusual flaring at plant seemed to be correlated with break-out of patches, hives, and rash and wasn't as regular as some other symptoms.

Second Child:

- 5½ years when first exposed in 1957. Severe head-ache and lethargy most pronounced symptoms with some nausea. Often severe enough to put hin in bed. When fumes were very bad in 1962 suffered from chest pains and uneven heart beat. Check with Dr. three times but never got to bottom of trouble. Some itchy scaly skin eruption on face and hands. Wakefulness, burning of nose throat and eyes. Occasional severe symptons but generally least visibly affected child. Severe head-aches, uneven pulse, and skin eruption have not occurred since leaving the area.

Third Child:

- 3½ years old when first exposed. Child most affected in general. Extreme depression and weepiness general unwell feeling, sick at stomach, lethargic, poor appetite, nosebleeds, some severe, two or three times a day at worst, often at night during sleep. Severe eye symptoms June and July 1962. Diagnosed as conjuctivites caused by a chemical irritant. Developed to as hemorrage condition on eyeball when sacs of blood hung down on eyeball nearly covering pupil. Medication made condition worse. Only improvement came with leaving area. Eye condition remained a problem until 1964 all though never as severe as 1962. Had a dry cough at night with wakefulness. Occassional outbreak of hives Symptoms disappeared when child left area. Eye condition has nener recurred and was believed caused by the extreme amount of flaring when Shell plant opened.

Fourth Child:

- $1\frac{1}{2}$ years when first exposed in 1957. Rashes and hive like spots first noticeable reaction. Sometimes severe crankiness, diarrehea, frequency and loss of control of bladder with severe scalding in area of diaper. Suffered the most of children affected by eye condition with painful eyes which developed very noticeable synpton of strings of fish-egg like blisters on eyeballs under lids. Dr's unable to diagnose condition Vision affected and also a noticeable dry cough. General symptoms of head-ache, stomach-ache, burning of nose, throat and eyes. Sores in mouth.

Fifth Child:

- First exposed at 1 month in 1957 sporadically with North or North East wind. Dr recommended new born baby to remain out of area until prevailing severe fume conditions improved. Severe diarrehea, extreme diaper rash and scalding, crankiness and skin outbreaks most noticeable immediate reactions. Recovery was quick with change to prevailing West wind. In 1962 developed conjunctivites with some patches of hemorrage on eyeballs. A few nosebleeds some skin rash eruptions, a dry cough. Only child who four times developed severe head-ache and nausea, lapsed into a deep coma-like sleep, awakened in 1-3 hours, apparently recovered and able to eat. No fever. This has never happened again since leaving the area.

Sixth Child:

- Exposed from birth. First severe reaction when five weeks old in Aug/60. Shell gas well on test. Cried continuously from early evening until next morning. Extreme digestive upset and diarrehea. Baby had been content and was breast fed. From Jan of 1961the baby had trouble digesting milk and often had diarrehea. Within ten to fifteen minutes of nursing baby would vomit thick sour lumps of milk. In Febuary, changed milk to powdered, then canned, ordinary cow's milk and pasteurized skim milk with no difference. Other babies, including her to this point had been successfully breast fed, some to eight months. In May 1961 we had severe fume conditions from Shell well on test. Baby became very ill with vomiting and diarrhea, very lethargic and listless to the point where she lay limp and wouldn't even hold up her arms while other members of the family lethargic head-aches and upset stomaches. Dr. Collins told us something had to be done immediately or she would be permanently physically and mentally retarded. The well was shut down that day and baby vastly improved in two days without medication. With every outbreak of fumes she refused to eat and in more than a year from 1963 to 1964 she gained only a pound and at one point lost it. In Nov/64 at four years she was underweight at 31 lbs. for her height and age. We moved in Nov. 64 and by Mar 3, 1964 she weighed 37 lbs. which was a gain of 6 lbs. in 4 months. By Oct/65 she weighed 47 lbs.

As well as poor appetite symptoms included listlessness, paleness, puffy swellings under eyes with some irritation and sticking of lids, wakefulness and nightmares, This child showed the most noticeable improvement when taken from the area.

Adult Male:

- Head-ache and lethargy most noticeable symptom when first exposed. Throat most affected with painful irritation. Continued indigestion with burping and gasiness when fumes present. Bladder and kidney upsets. All family members at times were sore around bladder and bowel openings as though something very irritating had been passed.

Adult Female:

- First exposed in last month of pregnancy in 1957. Extreme depression head-ache, hives and skin rash. Developed first serious sinus condition requiring medication. Un-born baby extremely restless continuously. Exposed again in last month of pregnancy in June 1960 when gas well on test and again unborn baby extremely restless. Became so uncomfortable checked to be sure baby in correct position and it was after a few days it became normal again.

  Severe head-aches with sinus irritation, sore chest with shortness of breath and dry cough, sore tongue with peeling. Hives and skin rash with outbreak of nickel-sized spots on torse, face swelled difficult to swallow. Black-out that couldn't be associated with another ailment. Severe stomache-aches associated with indigestion requiring medication.

  Have had no recurrence of hive condition, stomach-aches, black-outs, peeling of tongue and shortness of breath since leaving area.

The medicine chest contained the following prescriptions, antihistamine in pills and liquid form for hives, skin rashes and itchiness, antihistamine nasal spray for allergy ear conditions, antibiotic medication for eye irritation medicine for stomache-ache and indigestion and pills for sleeplessness and restlessness. They were used during outbreaks of fumes giving some immediate relief but no lasting effect.

Nearly all symptoms have been checked by or reported to Dr's. I have enclosed a photostat of a statement from Doctor Collins.

There seems to be no long range effect as far as allergy symptoms are concerned. One member has become allergic to penicillin, while the rest are allergy free. The third and fourth children who had noticeable dry coughs when exposed to fumes seem to have a weakness for lung ailments. One has twice had pneumonia, the other gets a bad bronchial cough with most veruses. The children have all grown to above average height, and have good athletic ability and normal scholastic ability. The third child at 19 has worked for several months with a maintenance crew in the Shell plant.

He has a persistent cough and complains of an upset stomach at times and has on occasion been exposed to H_2S but has not had a recurrence of the severe eye trouble, hives or nose bleeds he had before as a child. We down wind have always maintained that the workmen at the plant are not exposed to the same substances people living down wind from the stacks are.

There is an excellent source of information entitled, Air Quality Criteria for Sulfur Oxides which was issued by the U. S. Dept. of Health in 1967 which verifies most of the symptoms mentioned.

ANIMALS

Since our cattle are now out of the area more than half the time most of the problems have cleared up although there are times when we notice they all have sore watering eyes and cough more than usual. At the time of a bad fume outbreak from the Shell plant a yearling heifer was found dead and a second one having severe breathing difficulty. It was treated with antinistamine and recovered. The dead one was in the creek, the other near the water's edge.

Small two year old grass steers sold in the period 1950 to 1959 the average weight on 93 steers was 1068. From the period 1960 to 1968 the average weight was on 165 steers was 1039 lbs. under similar conditions. In 1969, the first year steers were sold which had spent more than half the time out of the area, the average weight on 39 head was 1060 lbs.

Following a fume out-break feed-lot cattle go off feed and even with the use of appetizers and digestive aids fail to return to normal for several days.

Respectfully submitted
Mrs. Gordon McRae

THE PINCHER CREEK ASSOCIATE CLINIC

DR. L. B. COLLINS
DR. M. R. HODGSON
DR. H. G. S. MEDLICOTT
DR. D. A. KERFOOT

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P. O. BOX 549
PINCHER CREEK
ALBERTA, CANADA

November 7th, 1964

To Whom It May Concern:

Re:- The Gordon McRae Family, and
The James Taylor Family.

This letter is written to re-affirm my previously expressed opinion that members of these families - noted above - develope various symptoms of ill health when the "smell" of gas is strongly present in and around their homes.

Younger children react more strongly than older children and adults i.e., they become more irritable and depressed and have greater loss of appetite. They usually awaken at night if the smell of gas becomes pronounced.

Other symptoms noted are headache and discomfort of eyes and throat.

Although I have no method of scientifically proving that these complaints are due to air pollution from the gas processing plants - nevertheless when there is no "smell" there are no complaints and when the families temporarily leave the area their symptoms disappear - therefore I believe there is a definite cause and effect relationship.

Finally, although no serious, permanent, illness has arisen to date among the members of these two families, still, they have been intermittently subjected to a very considerable nuisance.

Signed:- Lorne B. Collins.

L.B. Collins, M.D.

LBC/wb

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Have you been made aware of the services of the Federal Department of Forestry in Edmonton that can inspect vegetation and give you some assessment as to the cause of tree diseases? Have you used such services?

MRS. G. McRAE

Well, not recently. As you realize we have been away from the area most of the time since 1964. At this time we did have vegetation samples tested at the Lethbridge Research Station, when we found incidents of unusual appearances on different types of vegetation; but we were never able to get the definite answer as to the cause of these things.

DR. S.B. SMITH

Did they tell you they couldn't determine what the cause of death was or did they not, simply not send you an answer?

MRS. G. McRAE

Well, they replied; but they just stated that they were unable to identify the type of damage.

DR. S.B. SMITH

On the matter of rusting of machinery, are these the sharp exposed areas such as threads on bolts? Is this where the common corrosion starts to show, on exposed sharp pieces of metal, or where does it start to show?

MRS. G. McRAE

On any of the material that is exposed to the air. We have seen, on occasion, that a knife, which is left out overnight will show rust; only it won't show the definite pitting that will come later. Any type of metal, however, that is exposed to the air appears to show rusting, and any part that has to be moved or is part of a moving part of the machine becomes hard to operate because of the rusting.

DR. S.B. SMITH

Did you have any problem with you, with your house paint?

MRS. G. McRAE

We had no lead base paint that we could compare the problem with. The paint we used was a latex paint, and it doesn't show paint damage as the white paint with the lead bases do. The paint on the machinery shows deterioration. It just seems to almost vanish.

MR. W.A. FLOOK

The period of your experience is from 1957 to 1964, is that correct?

MRS. G. McRAE

Yes, and periodically from 1964 to 1967 we were in the area part time.

MR. W.A. FLOOK

You are still having these experiences?

MRS. G. McRAE

Yes, when we were in the area part time.

MR. W.A. FLOOK

1957 was the year the Gulf plant was built, wasn't it?

MRS. G. McRAE

Yes.

MR. W.A. FLOOK

In other words, you date your experiences from the time the Gulf plant was built?

MRS. G. McRAE

Yes.

MR. W.A. FLOOK

What type of odour did you detect at different times when you felt you were being assaulted by these vapours?

MRS. G. McRAE

Actually, there were a number of types of odours. There was a burnt type of odour which you associate with a smell of burning cabbage or onions. There was the rotten egg odour, which could be detected. At times there was an odour which resembled the smell of certain types of fuel. At times when wells were being tested, there was a very distinctive type of odour. I can't really describe it. It seemed to make you feel your tongue were coated.

MR. W.A. FLOOK

You couldn't identify any one particular type of odour that you considered was causing your trouble more than any other?

MRS. G. McRAE

Not particularly. There were types of odours which we believed we associated with hydrogen sulphide and sulphur dioxide. There were times when there were monitoring machines in our yard, when there would be very strong odours, and there would be no recording of effluents on the machine. Yet there had been very strong odours, and these types of odours we weren't able to actually identify as either odour as such. I believe there were combinations of odours.

MR. W.A. FLOOK

Would you think that at times your distress might have been due to the unpleasantness of the odour, rather than any specific physical effect on yourself?

MRS. G. McRAE

No. I wouldn't agree with that, because there were times when there was very little odour and we had very severe symptoms, so that I don't believe that there was an association.

DR. W.R. TROST

You have moved at least on a part-time basis to Beaver Mines west of Pincher Creek. How far west is that?

MRS. G. McRAE

Twelve miles and it's a full time basis. We have been there since 1967. We still own our property south of town though, and the men commute on days when there is work to do at the farm.

DR. W.R. TROST

Your permanent home now is 12 miles west of Pincher Creek? Does that get you out of the area that's affected by the odours?

MRS. G. McRAE

I have never smelled odours from the plant at the location where our house is. There are two or three wells in the area, owned by Texaco and processed by Shell, and there are times when work is being done at these wells. There will be an odour, but there has been nothing to bother us in any way.

DR. W.R. TROST

How much further are you away from the plant now than you were before?

MRS. G. McRAE

Well, as the crow flies I would say that we are probably the same distance from the Shell plant. The Shell plant used to be somewhere in the neighborhood of six or seven miles southwest of our home location. And now, I would believe it would be southeasterly direction, about the same distance, with a range of mountains or hills between, of course.

DR. W.R. TROST

Are you standing in a different relationship in respect of the wind?

MRS. G. McRAE

We still have the prevailing southwest wind, but the wind doesn't bring fumes from the plant in our direction. We are now northwest of the plant, where formerly we were northeast.

DR. W.R. TROST

Now, when your family returns to the farm, some of the symptoms may return again.

MRS. G. McRAE

Yes, the fumes are present.

DR. W.R. TROST

How long does it take for the symptoms to reappear?

MRS. G. McRAE

I would say that if the fumes are very strong, within an hour most of the symptoms are prevalent. If the fumes are strong when we arrive, there is immediate reaction and the burning sensations of the nose and eyes, and so on.

DR. W.R. TROST

Do you feel that you have become sensitized to these things, that your response to them may be quicker after exposure, than it was before exposure?

MRS. G. McRAE

Yes, very definitely. I feel that when we were first exposed to fumes we were not nearly as sensitive as we were later on, when even small amounts would create symptoms. This is one area that I feel is going to be very difficult to legislate, in that in an area where there has already been an industry of this type, and the residents in the area have been subjected to fairly severe amounts of fumes, legislation that would protect people who have not become sensitive to it will not apply to the families who still live in the area, who are sensitive now, because of earlier exposure.

DR. W.R. TROST

You were associated with the group of fifteen or seventeen individuals, were you not? Are there others who were associated with you whose experiences are not dissimilar from your own in a general way?

MRS. G. McRAE

The only difference in their experiences is that some families may have suffered a more wide range of symptoms and with more severity than others, but the symptoms are pretty well generally the same for everyone.

DR. W.R. TROST

You have case histories of the effect on humans and animals attached to your deposition, but you haven't said anything about them. Do you want to describe them just in outline now so that we'll know what humans and animals are involved? Are there no case histories from members of the families of those families who were associated with you?

MRS. G. McRAE

No, because this type of information was prepared on a personal basis, and would pertain only to the family directly concerned.

DR. W.R. TROST

You, together with those associated with you, were engaged in a court case that was settled out of court. Is that settlement a matter of public information?

MRS. G. McRAE

Well, I understand the settlement has been published in the newspapers. The amount; as far as the settlement concerning individual people in the court case is concerned was a matter of personal interest; and even among ourselves, some of us are not aware of how the settlement affected other members of the group. We are not aware of the monetary sums arrived at, and this sort of thing. It was a general settlement. In other words, I know what settlement was arranged for our family, but I am not aware of the settlements arranged for other families.

DR. W.R. TROST

Are there any comments that you want to make about that settlement, or about that subject, either the nature of the settlement, or the nature of the complaints if any that were agreed upon?

MRS. G. McRAE

It was a monetary settlement. I'm sure that every member of the group of people involved felt that it wasn't the settlement we were desirous of, in that we had hoped to alleviate a problem, rather than be forced to place a monetary value on nuisance and health. It was a disappointment to most of us to realize that in a civilized country, when it comes right down to the basics, money is the sole value.

DR. W.R. TROST

So, you were after a solution, rather than a settlement?

MRS. G. McRAE

Yes.

DR. W.R. TROST

Do you feel that in the period since that time with the change in regulations, and the introduction of new guidelines, all of which have not yet been enforced since there is a time scheduling involved with them, that there has been a movement towards what you might call a solution to these problems?

MRS. G. McRAE

I believe that both plants have made general improvements. On the other hand, I believe that our problem was not associated with the actual production of the plant, so much as it is associated with unusual operation of the plant. It seems that the upsets and malfunctions and things which go on in the plant to create unusual flaring conditions and this type of thing contribute to the symptoms and the health problems more than any other thing does.

DR. W.R. TROST

The recommendations that you have made here are made in the light of the present and projected improvements and regulations, but still are directed to things that need to be done?

MRS. G. McRAE

Yes.

DR. W.R. TROST

Do you want to elaborate on the tolerance level limits for downwind areas?

Mrs. G. McRae

I have always felt that it is very difficult to set a tolerance level, when it applies to humans and animals. In our case we were able to observe the effects on eight different people. Never at any time was the severity of the symptoms the same at any given time. Each person suffered from varying degrees of symptoms with the same exposure to the fumes. Some people have a tendency to be more allergic or susceptible, and that they will have more severe symptoms than others. Tolerance levels should be set so that people who may be more susceptible to fumes can have a fairly reasonable degree of safety from being exposed to an overly large amount of fumes. We found that once we had been exposed to large amounts of fumes and had a certain type of reaction, this reaction seemed to persist after this time, whenever there were strong fume conditions. We also found that different reactions among members of the family persisted at the same time. One person may be severely affected by hives, and another one would have a severe headache. It wasn't always the same symptom with each member of the family.

DR. W.R. TROST

You suggest that the stacks and flares be the point upon which attention is directed, rather than actual concentrations in the fields or at the ground level?

MRS. G. McRAE

We felt it's impossible to obtain an accurate sampling of conditions in the area, due to the size of the area, the terrain, and the type of weather conditions which exist. We feel that the place to begin is at the source. If the emission from the stack and the amount of flaring done can be measured and controlled at the source, this would eliminate a lot of problems downwind.

DR. W.R. TROST

Do you want to clarify why you think that result would follow?

MRS. G. McRAE

From our observations many of the episodes of the most severe symptoms we ever encountered were in connection with flaring and upsets at the plant and other things which went on in the field apart from the plant, or things that happened at wells. This sort of thing could be controlled in some manner that would eliminate a lot of the problems. In my records I have a number of incidents in which we can correlate actual happenings at the plant with typical types of symptoms on certain occasions.

DR. W.R. TROST

Might some of these occasions in which sudden flaring occurred have been responses to accidents of some sort that are in a sanse, difficult to control?

MRS. G. McRAE

We realize that there are times when accidents will happen which are of an uncontrollable nature, but there is a certain amount of human error in any type of work which involves human response. There are types of accidents which occur which we feel are directly the responsibility of carelessness or negligence within the operation of the plant. There is a type of grapevine that exists among the residents and things which go on at the plant, but we do find out sometimes what has actually happened when there has been a fairly severe incident of pollution. On a number of occasions it has been due to carelessness and negligence. We feel that workmen turn the wrong valve or someone allows a vessel to overflow. This type of thing is something that shouldn't happen within an industry, that can create conditions with such bad results.

DR. W.R. TROST

Your considered view is that the control should be at the stack and flare level?

MRS. G. McRAE

Yes, there should be a specified amount allowed taking into consideration the terrain and the weather. Sampling downwind should not be abandoned as such. We feel that sampling done downwind should be abandoned as far as tolerance levels are concerned. I think that it's very necessary that the Government and people connected with the Environment Authority know the conditions downwind. In my limited experiences we feel that it shouldn't have too much bearing on the tolerance levels as set by law.

DR. W.R. TROST

You feel it didn't get the proper control in the stack.

MRS. G. McRAE

Yes. There are times when weather conditions would be such that a very small amount of effluents may have a detrimental effect, if it gets to ground level.

DR. W.R. TROST

You recommend that industry be made responsible in some way for the periods of abnormal production. What do you mean by "in some way"?

MRS. G. McRAE

To our knowledge the existing legislation has never been enforced in any way. We feel that when things happen within the two plants that create severe pollution conditions some steps should be taken by someone, either reprimand or a disciplinary action or something of this nature. This would be very difficult to legislate I realize, but I would suggest that it may be done in a manner that would involve a fine or a tax or something of this nature, that could contribute to research or an area of the conservation field; and that if these incidents affect a family to the degree that they have to leave the area temporarily, or if they feel that conditions are bad enough that they should leave the area, that they should be compensated in some way.

PUBLIC HEARINGS

ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS IN ALBERTA

Pincher Creek, Alberta
October 2, 1972

Submitted by: William Main Family
Pincher Creek, Alberta

My husband and I and family of four children ranch in close proximity to the Shell Waterton Gas Plant. Our grazing land surrounds the plant. In the early years of plant operation, it became painfully apparent to us that the Shell Waterton plant had no industrial buffer zone. Because of our proximity (the western edge of two quarter sections were within a couple of hundred yards of the plant operation) and because of the prevailing westerly winds, our land, in fact, became the dumping ground of drifting sulphur from the sulphur loading area and boxcars, and blowing garbage and construction material. Our ranch headquarters was a half mile downwind from the sulphur loading area. Because of the nature of our winds (forty miles per hour is common, one hundred miles per hour occurs several times a year) the crushed sulphur was blown as far as our house in sufficient quantities to coat our surroundings with its yellow color. Our children suffered respiratory and digestive irritations and eye and skin irritations. At about this time a slug of liquid hydrocarbons was expelled from the flarestack and fell to the ground, setting our grass range on fire.

We felt the quality of our life was being reduced to an intolerable degree. As a result of our complaints we entered into negotiations with Shell Canada to create a buffer zone and to move our living quarters. The corporate mentality at that time (1962 - 64) did not allow for a recognition of air or water pollution and our negotiations had to be based on the visible drifting sulphur problem and the visible fire hazard problem. We subsequently traded our two down-wind quarters east of the plant for two up-wind quarters owned by Shell west of the plant, and moved our living quarters to the most south easterly corner of the ranch at great inconvenience to us financially. The buffer zone areas were offered to us as grazing.

This will serve as a history for the brief points I wish you to consider:

1. Health of our family

The nature of our work dictates that we ride horseback, drive vehicles or walk, as for fencing or driving cattle through fields immediately down-wind from the Shell Waterton Gas Plant. Often these endeavors are accompanied by stress and irritation. My husband and I suffer from irritated, burning eyes from the free sulphur kicked up from walking or riding through sulphur-coated grasses and shrubs. Many times while riding through our cattle members of our family have experienced particular stress -- a feeling of painful chest congestion from an acrid air pollutant. On one occasion in July, my son and I were riding in such a bad smelling area when we both felt this chest tightness. My arms began to feel numbness and we became alarmed for our safety and rode quickly out of the thick brush we were in, into an open field. Both our horses showed a dullness and stumbling accompanied by coughing. We learned later that day that the personnel at the plant had been warned to stay out of the down-wind areas of the plant. This was associated with the 'clean-up' operation at the plant. We feel that a situation of potential danger to unsuspecting neighbors should never be allowed to occur.

2. Health of animals

We have found an increasing incidence of respiratory disorders which we associate with plant emissions, experienced by cattle and horses. In areas of high sulphur content on the ground and in the pasture, cattle have digestive disorders with diahhrea. We have found it necessary to remove animals from certain pastures after only a week or so of grazing because of these problems.

3. Damage to fences, machinery

The wind is a constant factor in our part of the country. Those areas of our ranch which are down-wind from the prevailing south west wind are the areas most affected by our industrial afflictions: air pollution by sulphur dioxide and hydrogen sulphide, drifting industrial dust. The wires on the fences in this area are short-lived. Machines rust readily. Rusting is common, particularly below snow level where a high acid situation seems to prevail.

4. Damage to crops and grazing

Damage to crops is a real one for us, too. One quarter section of grazing was withdrawn from our grazing lease with Shell Canada because it was devastated with plant emissions resulting in such an extremely acid condition of the soil that no grass could grow. The adjoining quarter section and eighty acres of grazing is greatly affected also -- probably more than half the previous grass growth has been destroyed.

5. Water pollution

The main water course from the Shell Plant area settling ponds and through the devastated quarter section previously mentioned flows through our old ranch headquarter buildings. This is still the site of most of our cattle workings. We calve our cows in small fields surrounding these sheds and barns and our main working corral is in this area. On several occasions since the plant was built, noxious materials have flowed down this watercourse. Our spring (which was the source of house water) became polluted and no longer usable. Soon after this time we moved our family to our present house location. Since then the stream bed has become clogged with orange-colored residue and soil;cattle will not drink the water, the trees and growth all along its length (nearly a mile before it joins North Drywood Creek) are dead and dying.

In April of this year the latest disaster in the watercourse occurred. An overflow from a huge distillate tank occurred, spilling into the waterway. It was like a gasoline stream -- in fact, in trying to control the distillate, workmen set fire to a small dammed area and it burned like fuel. This material ran through two fields of calving cows, distressed by the strong fumes and on into the North Drywood Creek.

Twenty years ago these streams were beautiful, pure, cold mountain streams. Today some of them run in a deadened watercourse, carrying industrial foulness and soil that once was black and productive but which can no longer support life and so must be eroded away and driven along also.

Why is there such a great rush to mine, extract, pump raw materials out of this earth before considering what effect there will be on humans, animals, the plants, air and water we are endowed with?

QUESTIONING BY THE AUTHORITY

MR. W.A. FLOOK

You have had private dealings with Shell on all these incidents?

MRS. B. MAIN

We haven't on all of the incidents; on some of them we have, yes.

MR. W.A. FLOOK

You had, in fact, a settlement involving an exchange of land on one occasion; but you continued to use the land on the lease that you had surrendered to Shell?

MRS. B. MAIN

Yes.

MR. W.A. FLOOK

So that really you knew that this land was affected?

MRS. B. MAIN

Yes.

MR. W.A. FLOOK

Really, you are criticizing the situation, but you are not blaming anybody for the incidents that occurred on that land subsequently?

MRS. B. MAIN

I'm not criticizing the situation on behalf of us financially. I'm criticizing it on the basis that land, to me, is a trust; and not to be devastated.

MR. W.A. FLOOK

I assume that you are also a member of the Pincher Creek Industrial Research Pollution Committee?

MRS. B. MAIN

No, you assume wrongly.

MR. W.A. FLOOK

It may be that your position is substantially different from that which was put to us by the Industrial Research Pollution Committee, and may stand on a different ground for that reason. The evidence that you have submitted is similar and corroborative of the evidence that was put forward by the other individuals and by that committee: but it may be that your intent, the objective that you have in mind, is different. What do you think is the best path to take in the future?

MRS. B. MAIN

I believe many of the indications Mrs. McRae gave. I agree very fully with as far as having more control of the plant emission, not only the smoke stack emission, but of the water emission as well. I don't believe that they are flowing free and pure into the North Drywood River. During the years that the plant has been in operation , the North Drywood River, from the plant downward, has been a foam at times, a detergent-looking material. It smells foul, it's a plant effluent of some sort . There's no oxygen in the water and great patches of algae have appeared, and animals that we used to see in and around the river no longer inhabit these places. The fish population is far down. Mind you, in the last two years this situation has been greatly rectified. You feel sick, physically sick when you walk along the river. It was such a foul smell that it was actually a sickness to walk along there.

DR. W.R. TROST

You do feel that the situation has improved in the last two years?

MRS. B. MAIN

Oh, yes. It has improved.

DR. W.R. TROST

Do you also support the proposals from Mrs. McRae, the Municipal District, that research of certain sorts can helpfully be done to further improve the situation?

MRS. B. MAIN

Yes, I do. Mrs. McRae's idea that a fine be levied on upset situations in connection with the sulphur extraction business is an excellent idea. I think that this would well serve the research into problems to alleviate much of the situation.

DR. W.R. TROST

Do you have some optimism that the future can be brought about in a way that is satisfactory to you, a user of the land as well as to the producers of the material?

MRS. B. MAIN

I was rather disappointed when Mr. Naden said it was 1980 when the plant was going to cut down a bit. I thought maybe it might be dead by then. We were hoping that we might be able to outlive the Shell plant, but we're not too sure now. We do want to remain on our land, and enjoy our land. We love it, but we feel that we have a cancer, and anything that can be done to alleviate this cancer would be welcome to us.

DR. W.R. TROST

In respect of the drifting sulphur, has the sulphur dust tended to disappear in recent times?

MRS. B. MAIN

Oh, it hasn't disappeared, but it certainly has been much less, and the slating process is an improvement; but still much, much sulphur blows in the area. The area that Mr. Naden showed on his slides that was being reclaimed by Shell is a noble effort, but I can't imagine how it's ever going to get back into the state that it was before. That was a gorgeous mountain valley, and with luxurient grass and tree growth, and until a year ago when they began working on it, it looked like the moon. There was nothing growing on it, it smelled badly, there was no soil bacteria, I'm sure, and the trees were dying, and the undergrowth all died away. Where we used to pick saskatoon's, there are no saskatoon bushes growing now.

DR. W.R. TROST

You, nevertheless, do support the proposals for moving into the future that have been put forward this afternoon by various people?

MRS. B. MAIN

The monitoring system that is used by Shell is also a noble effort, but again I would like to see these monitoring systems set up in places where there are the most complaints coming from, or where there is a real problem. We asked for one of these machines to be set up on our place or in close proximity; and the man we approached said that they didn't want it in the high effluent area, they wanted it in outlying areas so that they could see how far the damage went.

DR. W.R. TROST

What did you think?

MRS. B. MAIN

I thought he was a very good member of his company.

GENERAL DISCUSSION

MRS. WRIGHTEMAR

My name is Mrs. Wrightemar, and I just wanted to comment on a statement made this afternoon by Mr. Basken, is that his name? Where he stated that they were objecting to the mercury up at the Shell plant. We have had analyses made of the water in the Drywood River, and we have found mercury in it as well as lead, arsenic and selenium. We live close to Drywood. There are lives concerned there, and although the relatives of the people perhaps pursued it, close neighbors have also. We were concerned. One neighbor became very ill, had a very high reading of lead. He is still in hospital much of the time or in a home. His life has changed completely. Another neighbor along Drywood River, a man also with a family was taken to Calgary, and his kidneys have been removed, and he spends his time going in for artificial kidney machines. People who have done any investigating have found out kidney damage so often comes from mercury. We have found this in the snow, and know that these pollutants come out of the stack. Our water well shows arsenic, lead, selenium, zinc. When reports come back from the Health Department or Conservation Board they are at tolerance levels, the highest tolerance levels. People in the area haul their drinking water, and we are concerned about the water in the wells and in the river.

DR. W.R. TROST

Are these deep wells?

MRS. WRIGHTEMAR

The one at home that had the most in it was a shallow well. Our deep well showed a reading of lead too, but we felt that it also got water from shallower sources.

DR. W.R. TROST

You feel that the material in the water came from the surface?

MRS. WRIGHTEMAR

We found it in samples that we had analyzed of snow.

MR. NADEN

We have been dealing with mercury in our plants and in our fields probably back to 1955 when I started; but mercury is very common in the field of measuring of gas in mercury mirrors, and we probably had been handling excessive volumes of mercury before we really realized the effect of mercury on people. Back in about 1957 we became extremely concerned with the build up of mercury in some of our plant facilities, and in the lab particularly. The Jumping Pound lab was torn apart completely, just to see what sort of accumulation you could get over the period of six years. We had sensitizing tape put in the drawers to see what the cumulative effect in the lab atmosphere would be, but we never did have effects in the larger parts of the plant, the areas where a meter may be taken apart and some mercury spilled. Mercury is also a very expensive fluid, and you do pick it up. You don't just let it go dribbling along the floor. I would think over the last three or four years, the mercury is gradually getting out of our business. I can't express the same concerns that Mr. Basken expressed this afternoon, that it is flowing into the creek. We do now measure on a regular basis, both lead and mercury content in the creek, in our effluents, in the combined effluent and Drywood. We have also measured lead and mercury, tried to detect lead and mercury in our stack effluents. We have tried to follow up on the complaints. I realize that we are always guilty until proven innocent. You get used to this and you do check out these sources to make sure that you are not the cause, because we don't know until we do check. I think we have taken the adequate measures to ensure that wasn't any at the time. We're still checking now on a very regular basis, at least once a month in both water sources. Thank you.

DR. W.R. TROST

Further comment?

MRS. G. MCRAE

I'm wondering if these men who are very well trained can work more than eight hour shifts at any time? Is there any time when they work more than an eight hour shift? I would feel that a person could lose their alertness. The work may be a little boring at times, and it's possible someone may lose his alertness. I would like to know too, if people do work more than eight hour shifts?

MR. B. NADEN

Can someone in the plant who has to be mentally alert efficiently work more than eight hours a day? They say yes, because there have been some plants in Canada and many plants in North America that have gone recently to the twelve hour shift. I don't think they can run a test on six months and say "yes, it works," or "no it doesn't work". With the existing eight hour shift, we quite often on necessity work a double, you'll work sixteen, or work a twelve, split one. It has to have an effect on an individual, and probably most significantly it depends on what sort of rest period he had before the time he is asked to work the double shift. They certainly are minimized, but you can't eliminate them. I can't really express an opinion, but I might be able to in a couple of years, because a lot more plants in North America, are going the twelve hour shift, three days a week. We're just beginning our second twelve hour shift but we feel in good shape.

MR. B. THOMPSON

We notice that when we have some of the worst pollution that it is as a result of four or five flares going. I'm wondering how much measurement or what control there is on the flare stacks, not just the main stack?

MR. B. NADEN

With the old plant, and even the new one, we do not have a metering facility on the specific flare line, because there are all different types, quantity, and composition of fluids or gases going through that line. You can't have one type of meter that will have the right co-efficient to measure any component that's going through it. You make material balance around the particular vessel that you're having a problem with and from which the gas is being flared. By subtracting flows in and out of that piece of equipment you should be able to determine what the flow is to the flare. These all have to be accumulated for the particular day and converted into tons of sulphur dioxide and into tons of sulphur to show up on your sulphur balance report. Now, a simpler plant, sometimes will have a meter on each flare system. With the size of some of our flare lines, thirty or forty inches in diameter, you may have a meter that will measure very large volumes. It's impossible for that same meter to pick up the small volume, so we do advise traction. To go to emission monitoring is going back fifteen years. Monitoring in the field picks up flares. It picks up everthing being dischared from that plant. The meteorological conditions in that area are so severe that we can exceed, that we can approach or exceed a ground level concentration before we are even close to exceeding the stack emission limit.

DR. W.R. TROST

A system which you were feeding in information about the winds, and the contours and so on would enable you to respond more quickly to those factors that in fact in the end would result in ambient ground measurements.

There are systems available, computer programs for your particular terrain. You can phone in data to something called a time sharing computer to find out what your flow should be. Each phone call would cost about $500.00 and the answer may be wrong. There may be improvements in techniques on stack but today we don't have them and some of the proposals just aren't sound enough.

MR. B. THOMPSON

The government through the Energy Resources Conservation Board further legislates in the flaring of sour gas as opposed to sweet, and also in the flaring of so called acid gases. In the event that a plant operator has to flare this acid gas, he is required by law to dilute that acid gas with a specified volume of diluting sweet gas to ensure a proper combustion of these products.

MR. NELSON

It appears to me from Dr. Klemm's remarks this morning that one or some of the political hearings we have had here, were a whitewash. Several people have suggested that every time they tried to go anywhere the Provincial Government or the Authority failed to co-operate. Provincial Government has a lot of responsibility for the fact that they didn't communciate or wouldn't communicate and obstructed any of the investigations going on, must bear a lot or responsibility for the position we're in.

DR. W.R. TROST

I think the only comment I can reasonably make is that we are conducting a Public Enquiry into the Environmental Effects of Sulphur Extraction Gas Plants, under the term of reference that I described to you earlier, at the request of the Minister of the Environment, and the Cabinet. When we have completed our Public Enquiry we will make the full public hearing a matter of public record. Our report and recommendations which will be sent forward to the Minister will then be released at his discretion.

DR. R. KLEMM

I've heard a number of people speaking about noxious fumes, or strong emanations of fumes; and this prompts a whole philosophy of the way the Government operates. I would say that the Department of the Environment and the Energy Resources Conservation Board are responsible for setting up the regulations; not monitoring the regulations but in seeing that the ambient air quality standards are met. The philosophy of the Government is that the plants will do the monitoring and the Government will police it and set up the regulations.

The government has essentially the same monitoring equipment as the plants. To me, this means that when somebody smells strong fumes and the Department of the Environment goes into the area and can't pick up anything, that it's because they are using the same type of approach and equipment that is used by the industry.

You can't take continuous monitoring equipment to everybody's pasture and monitor their fumes, but with the sophistication of today's equipment it's no problem to bring the air to the Department of the Environment, even in something so simple as a garbage bag. I'm fairly certain on my grounds because people in big cities go around with plastic bags collecting air samples, and then analyze them later on. The Department of the Environment and the Energy Resources Conservation Board haven't been as innovative or inventive in their approach to the people in the community as they have been with the industry.

PUBLIC HEARINGS RED DEER

OCTOBER, 1972

ENVIRONMENT CONSERVATION AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

Mr. J. Andrews presented a summary of the
French Petroleum Institute brief
presented in Pincher Creek

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. Andrews, in the summary you provided us, is it 25¢ and 56¢ per thousand cubic feet that you are referring to?

MR. J.W. ANDREWS

I think that 25 and 52, but I would have to clarify that, when I get to my other information.

MR. W.A. FLOOK

When you mention a recovery of 99.3% sulphur for the IFP-1 process, you are in fact discounting any recovery of carbon sulphide and carbon disulphide.

MR. J.W. ANDREWS

I am not discounting it; but the levels at which it applies are low, For example, that would be about 500 to 600 ppm CS_2 and a COS content of about the same amount. The IFP-1 process cannot cope with CS_2 and COS. I have considered these values for CS_2 and COS as not being extracted when I gave the overall recovery.

MR. W.A. FLOOK

They must be coped with separately if they are there in any appreciable quantity.

MR. J.W. ANDREWS

They must be looked at separately.

MR. W.A. FLOOK

If there is a significant quantity of carbonyl sulphide and carbon disulphide produced in the Claus process, can the Claus process be adjusted to convert these to sulphur dioxide?

MR. J.W. ANDREWS

Yes, there are two things that can be done. One has to do with the amount of hydrocarbons that are in the free gas, and the other one is a designed feature in a Claus plant itself which can be done with some planning.

MR. W.A. FLOOK

In order to get the efficiencies that you recommend for an investment of two thousand dollars, is it necessary to expend additional money for additional Claus equipment in order to take care of carbon disulphide and carbonyl sulphide?

MR. J.W. ANDREWS

No, in the case that I illustrated it is not because there were some CO_2 and CS_2 there. If they were in amounts which exceeded the limits I have just mentioned, certainly it would be to come out with the same end result.

DR. W.R. TROST

The IFP-1 can add on to a Claus unit, and in some cases the Claus unit might produce the most sulphur. In that case the IFP-1 would be mopping up the remainder, and that is presumably equally true for the IFP-2 process because of the interface between the successive steps. Can you give us some additional information as to the chemistry involved, the kind of treatment in the IFP-1 and the IFP-2?

MR. J.W. ANDREWS

In the IFP-1 process we use a solvent with catalyst in it. When the reaction occurs at the temperature that the gas is coming out of the Claus unit, from 50° to 70°, it occurs in a liquid phase. When sulphur is released it becomes soluble within the solvent up to the point that sulphation is reached. When the saturation point is reached it drops out down the column. Because it is above its melting point it is drawn out at the pile.

The basis behind IFP-2 is simply that we do not touch COS and SO_2 in our process. We must do this for a very high recovery process; therefore we will incinerate all the gases and we will have SO_2 plus some SO_3. We will then treat those by first collecting them in ammonia process recovery, and then treat the brine by evaporating it. The evaporated part is the SO_2 which is treated in a similar reactor system as IFP-1. The part which is not evaporated, which contains some SO_3 has to be put into a separate system which reduces the SO_3 to SO_2 and then brought into the main reactor system.

DR. W.R. TROST

If you start out with the Claus at a certain cost, then add an IFP-1 at a certain cost, and an IFP-2 at a certain cost they add on top of one another. Is there any way of combining these systems?

MR. J.W. ANDREWS

We can use some of the equipment from IFP-1 in the IFP-2 process, however, on a clean engineering basis, we would further look at it a bit differently. It is necessary in IFP-2 to put a gas scrubber into the system. This gas scrubber is dependent upon the volume of gas rather than the amount of SO_2, so that this is about 50% of the cost of the scrubbing end of the process. On the other hand, the downstream side, which is where we recover the sulphur, varies with the amount of SO_2 and H_2S in the gas and it still has to be treated. Therefore, that size will be much lower when sulphur values have been reduced down to low levels before it gets that far. We are saving on the investment of the rear end, 50% of the investment, when we add two steps.

DR. W.R. TROST

You had said that the values recovered for the additional separation phases that IFP-2 certainly and that IFP-1 probably wouldn't be sufficient to cover the costs of the installations themselves or their operation. It might have been in IFP-1, if that process had been carrying a good bit of the recovery and the responsibility as compared with the first step Claus, that it might work out in a different way.

MR. J.W. ANDREWS

It would, provided the sulphur price was higher than it is now.

DR. W.R. TROST

Would you be able to tell us how much extra costs will have to come from the gas itself? Can you do that now?

MR. J.W. ANDREWS

I can, but unfortunately I do not have a lot of the basic data. Much of this has to come from producers and some of the gas producers themselves. We would have to work with people of that nature in order to do this.

DR. W.R. TROST

You could give that confirmation back to us at a different time?

MR. J.W. ANDREWS

We certainly will try.

Typed copy of letters received from: Mr. & Mrs. Lloyd H. Chandler, Didsbury, Alberta, R.1. TOM OWO, September 6, 1972.

To the Environment Conservation Authority.

I welcome the opportunity of contributing a brief on Environmental Effects of the Operation of Sulphur Extraction Gas Plants in Alberta.

Living six miles from one plant and about twelve miles from two others has been educational where pollution from sulphur extraction is concerned, and such pollution is not confined to the air as some may suppose but may extend to water and soil contamination as well. My husband and I have had experience with some of the results of such pollution and we believe that it is only when governmental controls are applied that we will find a measure of relief. One problem in controlling pollution in the past is that we have had no support from government agencies. Until some of the practices of the plant nearest us were publicized we had no response to our complaints, and we saw outside pressure was necessary before the company would attempt to remedy the pollution they were putting out.

As for the pollution itself, serious damage is done to plant and animal life, an enormous weed problem has been created, soil erosion and rusted wire and machinery are common causes of complaint.

We also see adverse effects on trees, especially our maples and fruit trees. When we had cattle they were plagued by emphysema, sterility and crippled feet.

Emphysema in humans is known to be on the increase, and sulphur pollution may be a contributing factor in more serious disorders. We believe it is.

Pollution caused by the sulphur industry simply cannot be dealt with by itself. Every operation which produces sulphur is a contributing factor. For example, when petroleum first came to this district, a well here and there was drilled, then more wells, a refinery was established, then several pipelines were laid; gradually a railroad for hauling sulphur was built. Now a dam has been permitted for deep well injections and suddenly dozens, probably hundreds, of waterlines are being laid. Soil is again being disturbed and water is being taken from the Little Red Deer River. Unless very soon a long range look is taken at all this and serious consideration is given to the damage of air, water and soil who knows when the consequences will become irreversible?

This has long caused us deep concern. Thank you for letting us tell you about it.

Mrs. Lloyd Chandler
Lloyd H. Chandler.

Didsbury, Alberta, R. 1.,
October 6, 1972.

Dear Sirs:

May I submit an appendix to the brief I sent you dated September 6.

Some time ago Unifarm asked me to fill out a form they sent me, and to add a few remarks, which I did with such brevity I think I should add a few explanations.

I mentioned the absurdity of the monitoring devices used presumably to detect noxious gases in the air. I should explain that there are about 16 small monitoring boxes in this vicinity which are supposed to be read once a month. Since a lethal dose of poison could conceivably be registered on the apparatus within the box the result would be distributed over a month, and would not show the date, time or measurement of a large amount at a given time. It seems to me that to get a fair reading over a whole area a box would have to be set up on every square rod in that area. And I know of one box that was not read from fall till spring, for there were no footprints in the snow.

At one time there were three mobile units in the province which made a test for different substances than the boxes did, I believe. There may be more mobile units now. I hope not, for they must be expensive and in my opinion are quite useless. They are placed where prevailing winds might carry pollution, but what is a prevailing wind? Even a small wind shift could alter the amount deposited.

We have an infestation of thistles and other noxious weeds unknown previous to the advent of the petroleum industry. They are to be found in places inaccessible to cultivation or spray, for example, in tree windows, fencelines, corners, brush in pastures, and groves. Some time after a pipeline was laid on a quarter section of ours, Lloyd late in the summer walked down the line and counted 16 varieties of weeds, four of which we could not identify. Before, the only weeds were buckbrush and wild flowers. We feel certain these weeds were brought in by the contractor's machinery. Too, Russian thistles, which are not native here, are gaining a foothold, and I can show you weed infested areas used by petroleum companies.

The onus of proof is put upon us and this we cannot produce. (I am not now referring to weeds.) But we know these things did not happen till the advent of petroleum. Mr. Dobko, of the Social Credit Health Department, told us crippled feet in cattle could be hereditary. He had no proof of the genes of our cattle being faulty but was perfectly willing to accept the theory that they were. Let the industry produce proof that pollution from their plants and chemicals do not produce crippling, sterility, illness and death.

After finding so much fault I feel I must make a positive contribution. I feel that the government prior to the one we now have was far more concerned about industry than about agriculture and environment, and was too willing to overlook indiscretions on the part of the petroleum industry. I wonder how long the personnel have served in their various capacities. Only when they, the hidden power, are replaced with fresh personnel with new vision will we see any degree of improvement.

The gloomy picture of increasing pollution all over the world places an obligation on every man, woman, and child everywhere to contribute as little as he possibly can himself and to try to remedy what is already here. This applies to industry and if they do not comply, closing down their operations by order of the Government when they are found contravening given standards, and keeping them closed till such standards are restored, will no doubt create a healthy anxiety to conform to the spirit as well as the letter of the law.

Sincerely,

Mrs. Lloyd Chandler.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. Chandler, I wonder if you could tell us whether there were any symptoms to yourself, your family or other people as well as for cattle. Can you give any date on these symptoms as to when they started?

MR. L. CHANDLER

I started to notice six or seven years ago that I was getting awfully short of breath.

DR. S.B. SMITH

Could you describe what happens with the paint on your buildings or any other paint in the area?

MR. L. CHANDLER

It peels very fast. On the north side of our house we have an open porch and we have discovered a dirty brown oil covering the veranda.

DR. S.B. SMITH

Is there any blistering?

MR. L. CHANDLER

Yes.

DR. S.B. SMITH

On the sample you took of the water and mud from the Canadian Superior plant area, did you make any further contact with the E.R.C.B. about those two samples?

MR. L. CHANDLER

We phoned the Health Unit many times. We got no satisfaction.

MR. W.A. FLOOK

Are there any other farmers in your area who have been exposed to emphysema in cattle?

MR. L. CHANDLER

My neighbor lost 11 head. After my cattle got emphysema I had 12 sterile cows.I had to get rid of some of them because this continues to develop later.

MR. W.A. FLOOK

Your veterinarian could not give you any other reason why the cattle should get emphysema.

MR. L. CHANDLER

I was surprised that he would say that the green grass was the cause of emphysema. I asked if it possibly could be from the bad pollution that we are getting from these wells. He said that he was never able to pin anything down.

MR. W.A. FLOOK

Did he tell you that he was encountering emphysema in cattle that didn't live near to a gas plant?

MR. L. CHANDLER

I don't remember that he did.

MR. W.A. FLOOK

He didn't say whether he had had cases of emphysema in cattle in places away from a gas plant.

MR. L. CHANDLER

I don't remember him saying that.

MR. W.A. FLOOK

You never experienced rusted wire and equipment prior to the gas plant?

MR. L. CHANDLER

The wire used to rust but never so quickly or pit like it does now. Our fences all look like this and they never used to years ago. We could take up a fence and put it in someplace else. Now it is almost impossible to use the wire a second time. If you stretch it it will break; if you try to splice it, it stretches and breaks.

DR. W.R. TROST

I am interested in the sample of water that had yellow material floating on it. Was the yellow in it a solid that was floating on top?

MR. L. CHANDLER

It was floating on the top. They told us at the Energy Resources Conservation Board that if it was sulphur it would settle but I would imagine that this was sulphur ash from the stack.

DR. W.R. TROST

You would be familiar with spruce pollen?

MR. L. CHANDLER

I have never seen spruce pollen and didn't know there was such a thing.

DR. W.R. TROST

It hasn't come in other years?

MR. L. CHANDLER

No.

DR. W.R. TROST

Was it this same sample of water that was identified in one case as containing spruce pollen and in the other case by another person as having sulphur in it.

MR. L. CHANDLER

Yes. It was from the same pail and from the same neighbour. It was brought up at a meeting in Olds before the Energy Resources Conservation Board.

MRS. L. CHANDLER

Could I just show you a little bit of evidence to show you something of what we have encountered? This is a picture of my husband and the plant in the background. We have reported various times when there was waste matter and complained about the odors. The odors from the plant really have a deleterious effect on my husband's breathing. We called the Fish and Game Association and they called in Bill Musclewhite of the press, and the manager talked to him. He said that there was no way that water could set there from the plant either by intent or accident, yet there is a picture of a culvert with reddish fluid coming out of it into the ditch, with the plant in the background. That culvert, and two or three more, were all flowing into the ditch. They were there to carry waste matter into the ditch. The water from that ditch goes down into a troughing area,and it can go either into the Little Red Deer River or the Dog Pound Creek. Evenutally, if enough were put in it, rain could wash sediment from it into those rivers.

They not only have culverts there, but they have a pipe with a valve on top on the shoulder of the road. It isn't across the ditch on the road allowance, it is on the shoulder of the road. We were told that someone went by there and saw it spewing stuff all over the road. Someone had left the valve open. When we got there there was no emission from it; but I have a picture to show the facts. They deny all responsibility.

A neighbor got up one morning and his house was absolutely black. He got our son to go with him to the plant and they came back and looked at it. They completely repainted that house, inside and out, and replaced drapes that went to pieces; but they still disclaimed any responsibility.

DR. W.R. TROST

These reddish liquids, Mrs. Chandler, did they have odors? Did they smell?

MRS. L. CHANDLER

Oh, yes, definitely.

DR. W.R. TROST

What did they smell like, the Dickens?

MRS. L. CHANDLER

Yes, the Dickens. They're worse than that. Another time we took a sample of liquid to Bob Ross, friends of ours who have a brief in here as well. We took a tin of this stuff up there and he dipped a rag in it and set a match to it and it burned.

DR. W.R. TROST

Was it floating on water or sinking? Did you remember that?

MRS. L. CHANDLER

The water seemed to just be all one solid thick stuff, as nearly as I can remember now.

DR. W.R. TROST

Did it sink into the ground or stay on top of it?

MRS. L. CHANDLER

It seemed to stay on top of the ground; but, of course, we didn't dig down to see.

Typed copy of a letter received from:

Mrs. R.H. Ross
Harmattan,
R.R. 2,
Olds, Alberta.

October 4, 1972.

Dear Sirs:

First we wish to thank the Environment Conservation Authority for the informative material sent to us and for the opportunity to participate in the Hearings.

We live about four miles NNE of the Harmattan Canadian-Superior Plant and we also have on our farm a centralized battery and flare pit so we are no strangers to the problem of air pollution.

The many tons of SO_2 and other pollutants released into the air every day must inevitably cause environmental changes. And since the Creator made a balanced environment, man's interference on such a massive scale is bound to bring about a serious state of imbalance.

We feel that much research should be done to determine the effects of these air pollutants and in the meantime every effort should be made to keep air pollution to a minimum since its effects could have far-reaching and irreversible consequences. Apparently some research has been done already which indicates that sulphur causes an imbalance in the soil resulting in selenium deficiency in plants and subsequent deficiency problems in livestock. And if humans eat vegetables, grains and meats deficient in certain minerals, related health problems are bound to occur eventually in them as well.

We wonder what becomes of this vast quantity of SO_2. Does it remain in the air or is it eventually washed down to earth, there to contaminate soil and water? Does this cause the yellow dust which occasionally falls in some areas? We did not see this until recent years so cannot accept the spruce pollen or any other pollen theory. It has been suggested that we apply the sulphur test to this (if it burns it is sulphur). Well, it doesn't burn, but if this yellow dust is a precipitate of SO_2, which is oxidized (or already burned) sulphur, then its properties are different from elemental sulphur.

We will outline here some of the problems which plague us now but which were unknown or rare prior to the coming of the oil industry to this area:

(1) Excessive rusting of metal, machinery, tools, fences is an indisputable fact. The effect is easily related to cause (SO_2 combining with moisture vapor in the air, H_2O, to form sulphurous acid.).

(2) Chronic, low-grade, respiratory ailments in our family - sore throats, coughs and stuffiness which fail to respond to good diet, extra vitamins etc. I should mention too that of late, other people, new comers to the area, have commented on sulphur-plant odors which we have not noticed. Could we have partially lost our sense of smell from long exposure?

(3) Coughs, pneumonia and some deaths therefrom in cattle, particularly feeder cattle. We have had to install expensive antibiotic-metering equipment to cope with this now-chronic problem.

(4) Hoof troubles and other problems seemingly related to calcium deficiency but which do not respond well to corrective treatment.

(5) More sterility in cattle than formerly but tests indicate no disease.

(6) We believe that foliage can be affected directly in some cases of excessive air pollution - I am thinking of a specific instance which occurred some years ago very near the Can-Sup Plant at Harmattan. However, most defoliation and injury to trees has been caused by bugs, worms and disease. But since such conditions seem to be more prevalent in recent years, we wonder if air pollution is weakening the trees, making them more susceptible to attack from insects and disease. Also, are some beneficial insects dying off from air pollution?

Some of the above-mentioned problems are not readily related to cause. We can only compare what was and what is and wonder what caused the change. We feel that there are many questions to be answered. What direct effect do these poisons have on people, animals, insects and plants? What imbalances are being caused in the soil resulting in the inability of plants and animals to assimilate certain vital elements?

We realize that the problems are very great. In a world where more and more people are using and wasting so much of everything, particularly the energy fuels, the problem of supplying this demand without terrible damage to the environment is really awesome. The profit motive and the pressure to create jobs complicates the situation but there has to be something very wrong with our values and our system when we must ruin the earth for profit and to employ men.

We do need research into the effects of air pollution but we need even more research into how to remove the cause. And most of all we need re-education of the people themselves and a change of heart so that there should be eagerness to keep this old planet clean and beautiful and the willingness to work, if need be without pay, to accomplish that end.

There should be no waste of our valuable things. A good public transportation system and encouragement to use it would save a lot of gasoline. And these natural gas flares which are being used for mere decoration are one example of a senseless waste of a fast-depleting resource. Conserving, reusing and recycling would eliminate much of the need for tearing up the earth in the endless quest for more raw materials. Because of the resulting damage, we have long deplored the fact that oil must be extracted in a good agricultural area. We have been told that only 3% of the earth's surface consists of arable land, which we can well believe considering how much is covered by water, ice, deserts, mountains, rain forests, swamps, tundra and otherwise barren land. And it is a sobering fact that much of that precious 3% is being ruined or otherwise taken out of production while the earth's population increases rapidly.

We appreciate the fact that this government has shown a sincere desire to tackle the problem in a meaningful way and we hope that they can gain the wholehearted cooperation of industry and the general public. For what benefit our profits, our luxuries, our self-indulgence if we end up as one man phrased it, "Croesus sitting on a rubbish heap".

Respectfully submitted,

MRS. R.H. ROSS

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Have you or your neighbours personal knowledge of wide-spread rust damage downwind from the plant that you are speaking of?

MRS. L. CHANDLER

Everyone of them complains about it.

DR. S.B. SMITH

It's not an isolated thing?

MRS. L. CHANDLER

It's completely universal as far as we're concerned.

MR. W.A. FLOOK

Mr. Chandler a moment ago indicated that baling wire of the type represented by the sample was now extinct. Could it be that the reason the wire is rusting faster these days is because it is not as good quality as the original wire was?

MRS. L. CHANDLER

This was of good quality. It had to be to be tied around the bale.

MR. W.A. FLOOK

The only point I am making is that it may be different. The wire that is rusting fast now is different from the wire that did not rust fast in the past.

MRS. L. CHANDLER

I really couldn't say about that.

MR. W.A. FLOOK

Is there a possibility?

MRS. L. CHANDLER

Yes, there is a possibility.

MR. W.A. FLOOK

You said that there is a flare pit on the Ross property, and a battery. You are acquainted with this flare pit are you? How often does it burn?

MRS. L. CHANDLER

I think it burns continuously, day and night, year in and year out, twenty-four hours a day.

MR. W.A. FLOOK

Thank you very much, Mrs. Chandler.

MRS. L. CHANDLER

Can I mention such problems as weeds? We have a terrific problem there, especially thistles. They get in along the fence lines, and especially in groves; and you can't spray them there because of possibly injuring the groves. We have a weed problem that we never had before we had our land torn up for the well sites and such.

DR. W.R. TROST

Weeds have grown back rather than other grasses?

MRS. L. CHANDLER

Oh, yes, where the railroad took a pie-piece corner of our land. They bought the entire corner rather than give us an underpass so the cattle could pasture on that small corner. From a nieghbor's place they brought down clay and put it on that corner and nothing will grow; no grass, just weeds.

DR. W.R. TROST

Has there been any difference in the intensity of these experiences in the last year or two as against earlier years? Have things gotten better or worse?

MRS. L. CHANDLER

You mean the bad odors and so on?

DR. W.R. TROST

Yes.

MRS. L. CHANDLER

They are not as bad as they were, but there has been a continual round of fights, and naturally only a handful protested. The rest can endure.

DR. W.R. TROST

Do you talk to the companies?

MRS. L. CHANDLER

Yes. I phoned them many times.

DR. W.R. TROST

Are disagreements handled in a friendly way?

MRS. L. CHANDLER

I talked to the manager of the Canadian Superior Plant a number of times, and he answered me in a very short and bored tone when I phoned. The Energy Resources Conservation Board had a meeting at Olds last spring and we went there. The manager came to see us, spent an afternoon with us; it was very, very congenial, and has been since.

Brief submitted by: Cecil Robinson

Mr. Chairman, Ladies and Gentlemen, we at Erskine have the same trouble, wire corrosion, paint, things of that sort. We believe we have had health problems, but we can't get any of the doctors to say that is is related. My wife has lost her sense of smell. I think it's from that. Before the Board took over we were surrounded by twenty-seven flare pits. Now, it's all unitized and there is just the one.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

I would like to ask you to describe two things: the amount of odour in the air now as compared to before when the field was not unitized; and secondly, since you live rather close to the present flare stack, what the effect is or has been on your present abode?

MR. C. ROBINSON

I would say that it's a quarter of the odour now, and it's only odd times that we notice it. Strangers coming in notice immediately that there's still odour there.

DR. S.B. SMITH

You are saying that there has been a distinct improvement since the field was unitized.

MR. C. ROBINSON

Very much so.

DR. S.B. SMITH

You mentioned right at the outset that there were problems of corrosion. Could you explain that a little more fully?

MR. C. ROBINSON

Our fences only lasted three years. We had to replace it; it was impossible to stretch wire because it was eaten right through. In about four years it all fell to the ground. I don't know how long it will last now. I put up some two years ago, and it's in fairly good condition, though it's starting to rust at the barbs.

DR. W.R. TROST

You said that friends and neighbours of yours also had the same experiences.

MR. C. ROBINSON

Yes, the oil company was going to have a joint meeting with us to discuss remuneration, and before we knew about it, they had been around the outlying people and had them sign up a quick claim allowing a percentage depending how far out they were. They had a map drawn up; in the heavy area it was 100% and further away it was less and less. In the 100% area they were allowing $180.00 a mile for fence. They would allow 20% of the fence damage amount on any other damage, paint or machinery damage. The most you would get on a half section would be about $500.00 fence damage. Twenty percent of that for the rest of your damage. There were two of us that didn't sign. We thought that we had put in so many fences that if we didn't sign we would try for more than that. We went to the Environment Board, and as soon as the Oil Company heard they withdrew their offer.

DR. S.B. SMITH

Is that the way it stands now?

MR. C. ROBINSON

Well, we tried to do the same as they did at Pincher Creek. I don't know what is going to come of it. That's the way it stands now.

DR. S.B. SMITH

You did make some mention of health problems. Do you want to elaborate on any of problems of that sort of thing?

MR. C. ROBINSON

I don't think I can when we can't get any backing from any doctors saying it could be that. I know I used to have mink, and shortly after the oil came in, the pelts deteriorated. I couldn't get a clear color any more, it was all a brownish tinge. I blamed it on the oil, but I couldn't get any proof of it.

Submission of Chevron Standard Limited

Regarding Environmental Effects of the Operation of Sulphur Extraction Gas Plants, With Particular Reference to The Nevis Operators' Committee Gas Processing Plant at Alix, Alberta

to

Environment Conservation Authority Hearing
Red Deer, Alberta, October 5, 1972

Presented by: E. Cudby

FOREWORD

Chevron Standard Limited participated in the preparation of and fully endorses the submission by the Canadian Petroleum Association (CPA) which covers in some detail, the subject of environmental effects of the operation of a natural gas processing plant with its sulphur extracting facility.

Rather than repeat much of the information contained in the CPA submission, Chevron's submission is restricted to a discussion of the features of the Nevis Operators' Committee Gas Processing Plant which can influence the environment in the area.

Chevron Standard Limited, as operator of the plant on behalf of the working interest owners, is responsible for maintaining field and plant efficiency and safety at a high level to minimize danger to the plant and field staff, the public and the ecosystem.

Chevron Standard Limited welcomes this opportunity for the industry to present its views. We strongly favor the procedure of consultation between Government, Energy Resources Conservation Board and industry prior to enactment of new environmental legislation and issuance of regulations and guidelines thereunder. Such a procedure served very effectively in the past to establish realistic standards and regulations which have been shown to be effective in protecting the environment. It is our hope that, as a result of these hearings, the roles of the Department of the Environment and the Energy Resources Conservation Board will be reexamined and that the role of each will be clearly defined, their objectives unified and administrative procedures streamlined in the interest of preventing confusing and burdensome multiple standards and controls.

INTRODUCTION

The Nevis Operators' Committee Plant was built in 1959 and is located 19 miles west of the farming and business community of Stettler. It is one of two plants processing gas from the Nevis D-2 and D-3 wet gas reservoir and was built at a total cost to date of some 6.7 million dollars.

The plant was built to meet the demands of a growing energy market and has been expanded twice since it was first completed. It is currently capable of processing 100 million cubic feet of raw gas daily, giving marketable products of 80 million cubic feet of sales gas, 1,200 barrels of condensate and over 250 long tons of elemental sulphur. It employs 27 operating personnel and injects over 1 million dollars annually into the local and provincial economy through payroll and operating costs.

With the exception of sulphur, the plant products have a ready and expanding market. Initially sulphur had a marginally economic value and was produced largely as an environmental protection measure. Through diligent industry effort and a reduction in transportation charges, economically attractive world markets for sulphur were developed. As the demand for Alberta's natural gas grew, the number of sulphur extraction plants increased rapidly to the point where Alberta sulphur saturated the world markets, once more causing prices to tumble. This price situation is currently being further aggravated by worldwide efforts by all industries to reduce air pollution through recovery of sulphur from previously vented gases. Thus, the outlook for sulphur prices for at least the next decade is discouraging and we must look forward to continuing marginal economics of production and growing sulphur inventories for some years hence.

In spite of this, the Nevis Gas Plant production of sales gas and condensate continues to meet consumer demands, and the extraction of sulphur, economic or not, remains a necessary surplus by-product in an industrial society.

To the citizens who live in the vicinity of a sulphur extraction gas plant, the matter of environmental protection is of utmost and primary concern. The fact that this gas plant is a successful economic unit, providing valuable services to the community is often not recognized by that same community.

Since we, too, live in the community and thus have more than a monetary interest in this enterprise, we appreciate and understand this position, and have, through proper governmental and regulatory channels, as well as voluntarily, sought from the beginning to reduce any negative environmental effects of our presence in the community, and have striven in every way to improve our performance, not only in the community but with the people and Government of Alberta as a whole.

It is to this latter objective that we now wish to address ourselves.

ENVIRONMENTAL CONTROL MEASURES

We recognize that the process of extracting sulphur at gas plants, no matter how efficient, (and Nevis Operators' Committee Gas Plant is designed to operate at over 98% efficiency), has the potential to create disturbances to normal living conditions during periods of plant upset.

However, in order to control both the frequency and duration of plant upset, the following operational procedures apply.

1. Firstly, the raw feed for this gas processing plant with its sulphur extraction facilities is transmitted from the many field gas wells through a network of various sized pipelines.

   The gas wells are equipped with two separate, different, and automatic sets of shut-in devices to control a system failure as follows:

   (a) A downhole shut-in device is installed in each gas well that automatically shuts the well in below ground level, in the event of an abnormally high or low pressure occurrence at the wellhead.

   (b) A surface installed shut down device automatically shuts the well in at the well head if a failure in the heater facility, manifold or transmission line occurs on a high or low pressure signal.

   The field gathering system itself is equipped with strategically placed corrosion monitoring devices, such that any corrosion development is recorded. In addition, a corrosion protection program minimizes corrosion development. Both of these programs are designed to eliminate failure in operation.

   Block and check valves are also strategically located, to minimize feedstock emission to the atmosphere, should a pipeline failure occur.

2. Raw gas input is limited to an Energy Resources Conservation Board approved volume and is regularly monitored as to hydrogen sulphide content.

3. The process of conversion of hydrogen sulphide to sulphur is monitored and controlled to assure the highest efficiency.

4. Special sulphur plant tail gas cleanup facilities are incorporated to enhance the plant sulphur recovery and minimize incinerator stack pollutants.

5. The tail gas is monitored continuously to ensure the optimum performance of the three stage Claus plants and the tail gas cleanup facilities.

6. After the treated tail gas is incinerated the resultant stack gas is monitored continuously, to ensure that emissions do not exceed prescribed limits set by the Energy Resources Conservation Board.

   With this sophisticated monitoring equipment, upsets can be detected early and corrected, such that the duration and effects of the upset are minimized. Information on the upset and corrections taken are promptly telephoned to the Board, to assure the concerned governmental agencies that no harm has or will occur.

7. In the unlikely event of an operational upset in either the processing plant or in the field facilities that can seriously affect the gas plant area residents, Chevron has prepared a resident emergency evacuation plan which would be immediately activated. This plan has been successfully implemented and is operational.

8. (a) Ground level monitoring of hydrogen sulphide, sulphur dioxide and sulphur dust is maintained on a year round basis, as a record of how successful the operation of the gas plant is, relative to the ambient air quality standards.

   Studies are also made on the effects of sulphur compounds on the environment, on a first hand experince, or literature or research review basis, in order to respond positively to any irregularities that might emerge.

   (b) Also continuously monitored and recorded are the plant site meteorological conditions that include barometric pressure, temperature, precipitation, wind speed and direction.

   Regular reports are prepared by Chevron Standard on the effects of these local meteorological conditions on the course of our industrial activities, and ways and means to circumvent negative effects, before they occur.

9. (a) All runoff water from the plant area and plant effluent (i.e. boiler feedwater blowdown) are impounded and, before release under Government sanction to the Red Deer River, water analysis tests are taken to assure that it is safe for disposal.

   (b) All toxic liquid waste products from the processing plant are impounded and burned.

10. An in-plant environmental protection program is in continuous operation, being maintained at both the operator and plant supervision levels.

    This includes, "in-plant,"

    safety procedures, guidelines and practices
    fire protection services
    hydrogen sulphide warning system
    noise and hearing protection program
    an Emergency Procedures Manual

These programs are on file with the appropriate government agencies, who also maintain inspection services.

11. Chevron Standard presently supports both local and foreign research programs on various environmental matters in order to assure our awareness in continuing developments for environmental protection. Where such investigations reveal deficient areas, we have and will continue to respond to improving production practices, where local requirements dictate, or economic and technical capabilities permit.

CONCLUSIONS

1. The Nevis Operators' Committee Gas Plant has been in operation since 1959, and in that period of time has experienced a number of upsets which have resulted in criticism at the community and government levels. The majority of all such problems have been resolved to date.

2. Operational upsets at Nevis Operators' Committee Gas Plant will probably occur from time to time, but we can assure the public that through our continuing surveillance and efforts, we will find solutions to vexing problems that interface with the community, no matter how minor they may be.

3. To the best of our knowledge there is no evidence or record of any permanent damage to soil, vegetation, animal or human life.

4. There is a clear and recognized disparity between the records of pollution monitoring, and the records of complaints. We will endeavor to close this apparent credibility gap through continuing efforts in education, communication and plant upset problem solving.

5. As noted in the "Foreword," we fully endorse the Canadian Petroleum Association submission on this subject and it is our hope that its submission will assist the government and the public to arrive at the most realistic and practical perspective, in assessing the environmental effects of the operation of sulphur extracting gas plants.

6. We cannot afford to be at odds with the community.
   We live in it as well as work in it, and we recognize it is in our best interests to protect the environment and at the same time enjoy the position of being a good, responsible, and welcome neighbor.

We do not believe, at this time that the evidence supports more stringent ambient air quality standards - they are already more than adequate, considering the basis of their development.

While we maintain that only one regulatory agency should set a given standard, thus eliminating duplication of standards by more than one agency, we also believe that the responsibility for determining applicable sulphur gas plant efficiencies to meet these standards rightly belongs to the operator. It is incumbent upon the operator to prove to the Energy Resources Conservation Board that the plant design represents the best possible alternative, based on available technology, to meet the highest economic recovery of available resources, and satisfactorily meets all environmental and pollution control standards, as set by the Department of the Environment.

We further submit that each gas processing plant with sulphur extraction facilities is unique and design and operations approvals should continue to reflect its uniqueness. We do not agree that each such plant, regardless of its location or nature of its operation, should be subjected to a stereotyped set of requirements but, rather, its unique situation should be taken into consideration when contemplating the imposition of standards.

Chevron Standard Limited has met the challenge to improve the facilities in this plant to more than meet the stringent environmental regulations, and, notwithstanding upsets that may press upon the allowable limits from time to time, or such shortcomings that may stress efficient operations, we will resolve our internal operating and external environment problems as promptly and expeditiously as possible in order to assure an acceptable and resourceful economic unit in the community.

As conditions change and the need for adjustments in acceptable standards becomes apparent, we look forward to a continuing involvement and an intensification of assistance to government, industry and the public alike, in reaching whatever levels of environmental purity are appropriate and consistent with good practical environmental, technical, and economic parameters.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Most of the people we've heard, including the citizens who have had problems, have suggested that things are a lot better now than they were in the past; and yet there still appears a credibility gap. Have you had very many complaints about the operation of the Alex Plant in the last couple of years?

MR. E.E. CUDBY

We're very happy to say that we have not had very many complaints in the last couple of years.

DR. S.B. SMITH

So, most of that was when most area complaints for that particular operation were before the fields were unitized, before that plant was built in? Before the Alex plant was built? Have the complaints pretty well disappeared since the Alex plant was in operation, have they decreased more in the last couple of years? Did the complaints go down steadily from the time the plant was first in operation?

MR. E.E. CUDBY

Yes. I think possibly as is true with any plant that goes into operation, they do have problems, and you are inclined to have the community interfaced with the plant with problems that do arise. They have reduced over the years to the extent that right now we rarely hear of a complaint.

DR. S.B. SMITH

Could you indicate what is the general average H_2S percentage or sulphur percentage in the raw gas from the gas you're processing there?

MR. E.E. CUDBY

I'm aware of its approximate figure, but I would like to turn to Mr. Newshouse, if you want an exact figure.

MR. NEWSHOUSE

The average hydrogen sulphide concentration is 7% and carbon dioxide is 2%.

DR. S.B.SMITH

You said that the recovery initially of sulphur in all plants was largely because of environmental reasons, that is it was not permitted to put this sulphur into the environment so it was recovered for environmental reasons presumably. Could you give some assessment of these two factors? Could you say if that's so, if any dollars recovered from the sale of sulphur are in the nature of a windfall? Do you know of new or expanded research efforts for new uses of sulphur to increase its saleability?

MR. E.E. CUDBY

I would hardly refer to the sale of additional sulphur as being a windfall. Chevron Standard as a company is not able to sell all the sulphur it makes, so we have surplus in stock pile.

DR. S.B. SMITH

But the brief states, "sulphur was produced largely as an environmental protection measure". Wouldn't you have produced the sulphur in any event to protect the environment, whether you could sell it or not?

MR. E.E. CUDBY

Well, that's part and parcel of the approval, whereby we're permitted to operate the gas plant.

DR. S.B. SMITH

Aside from the use of sulphur in fertilizers and similar efforts, are there efforts being extended by your company in order to attempt to pick up the uses or expand the numbers of uses of sulphur?

MR. E.E. CUDBY

Very much so,on the part of many companies and industry sponsored research groups, and of course our own research, our own Chevron Research in California.

MR. W.A. FLOOK

You make a statement that any plant that's engaged in the business of extracting sulphur has the potential "to create disturbances to normal living conditions during periods of plant upset". Is that intended to be just a broad philosophical statement, or do you have some specific adverse effects in mind?

MR. E.E. CUDBY

Essentially, this is a broad statement that any industry that moves into any area is inclined to upset the community, whether it's a few people or a lot of people. In that sense there is a disturbance to the area; and certainly in some cases of course, there could be exceeding disturbances as a result of upsets.

MR. W.A. FLOOK

Several people here this afternoon have indicated specific effects, which they quite honestly believe have been caused by something that has been produced by the sulphur extraction gas plants; yet they all seem to admit that they have no specific proof. Would you like to comment on what you think the cause-effect relationship here is; whether you think that it is likely, unlikely or not possible that these two things are related?

MR. E.E. CUDBY

As more research is done on the environment, with respect to the effect of different industries, we will find answers. I think the people that are making their statements here this afternoon believe what they say; and I think, as was pointed out by Dr. Klemm, that it's a very complex industry, and it's very complicated trying to find the right answers.

MR. W.A. FLOOK

You also seem to feel that the imposition of controls from two different points of view is burdensome and to some extent limiting to your activities. You state that the efficiency of a plant should be the operator's responsibility exclusively. The efficiency control is exercised by the Energy Resources Conservation Board, and I would suggest that possibly the reason for this might be as much a conservation measure for sulphur as a resource, as it is an environmental protection measure. Would you subscribe to this?

MR. E.E. CUDBY

I am sure that there is conservation involved in this. I think it's a question of the degree of conservation that we are talking about, and this is a grey area which is a problem to the industry.

MR. W.A. FLOOK

I see. You also indicate that there is a clear and recognized disparity between the records of pollution monitoring and the records of complaints. This is a very interesting, and I have no doubt, true statement; but a little further down, you say that ambient air quality standards are already more than adequate. It seems that there is a little bit of an inconsistency here, because the disparity surely wouldn't exist if the ambient air quality standards were more than adequate.

MR. E.E. CUDBY

The point that I think we are trying to make really is that we recognize that you have to put yourself in their shoes and recognize what they're talking about, and this can be very difficult for a person living outside an area. It's very difficult at times to figure out just exactly how you relate the complaints to the record of your achievements. When we talked about the ambient air quality standard, we would have to add that on the basis of the development, the criterion is built into the ambient air quality standards of the Department of the Environment. I think they are two different things.

MR. W.A. FLOOK

You don't think that it is inevitable that ambient air quality standards must be tightened in order to stop complaints from occurring?

MR. E.E. CUDBY

That's correct.

MR. W.A. FLOOK

Thank you very much.

DR. W.R. TROST

You will recall that part of our term of reference is to review legislation and regulation and to see whether or not they are serving an adequate purpose. You say that you hope that as a result of these hearings the roles of the Department of the Environment and the Energy Resources Conservation Board will be re-examined, and that the role of each will be clearly defined, their objectives unified, and administrative procedures streamlined in the interest of preventing confusing and burdensome multiple standards and controls. Now, the implication is that things aren't all that good right now. Do you want to elaborate a little bit?

MR. E.E. CUDBY

I think one particular area is rather confusing; that is that the Energy Resources Conservation Board does have in their regulations an ambient air quality standard which is different from the ambient air quality standard under which the Department of the Environment operates.

DR. W.R. TROST

Can you describe that more fully?

MR. E.E. CUDBY

The figures that are laid down by the Department of the Environment say that it has 0.3 parts per million sulphur dioxide as the limit insofar as ground level concentrations are concerned. I believe there is a regulation within the Energy Resources Conservation Board that indicates that they are operating at 0.2 parts per million for ground level concentrations of SO_2.

DR. W.R. TROST

These are at the same ground level, at the same spot?

MR. E.E. CUDBY

This is what appears to be.

DR. W.R. TROST

Isn't it the case, though, that the Department of the Environment sets the standards and the Energy Resources Conservation Board enforces them, that be simplifying it a little bit?

MR. E.E. CUDBY

It would be my understanding that the Department of the Environment would set the ambient air quality standards and that the Energy Resources Conservation Board would police them and enforce them.

DR. W.R. TROST

But there seems to be in this particular case some ambiguity in the situation?

MR. E.E. CUDBY

Yes.

DR. W.R. TROST

Do you know whether this is being righted? Is it a matter that has come up recently, or has it a long history?

MR. E.E. CUDBY

This seems to have been implied in the last six months; and special note was made of it with respect to an application saying that this ambient air quality standard which we wish you to meet is, in fact, more strict than the Department of the Environment.

DR. W.R. TROST

Do you find any difficulty, in principle, in the division of responsibility between the two agencies?

MR. E.E. CUDBY

In principle, I don't know, sir.

DR. W.R. TROST

In principle, as you pointed it out, the Department of the Environment sets standards and the Energy Resources Conservation Board would enforce them. Now, following this general line of thought a little further, there are guidelines that the Energy Resources Conservation Board has issued that indicate levels of sulphur recovery now and into the future. Can your company meet these guidelines which become, as I understand it, somewhat more restrictive as time passes?

MR. E.E. CUDBY

You mean, is the capability there to meet these?

DR. W.R. TROST

Yes.

MR. E.E. CUDBY

This would have to be something looked into in the case of each particular gas plant, as we suggest that each gas plant is unique. In terms of the uniqueness we would have to determine whether it is practical, or even desirable.

DR. W.R.TROST

You are presumably looking at that matter internally to the company?

MR. E.E. CUDBY

Yes, sir.

DR. W.R. TROST

Are you anticipating difficulties in meeting these guidelines?

MR. E.E. CUDBY

The difficulties that one might anticipate may certainly have to do with convincing the regulatory authority that our objection is valid.

DR. W.R. TROST

There sometimes is a different view as to where the guideline control should be placed, whether in the emissions in the stack or at the ground level itself. Have you a preference for either one of these positions?

MR. E.E. CUDBY

I take the position that once the design has been made on the plant, that has been essentially approved by the Resources Conservation Board, that the success of that operation should be based on the ambient air quality standards or whatever other standards relate to the operation of this plant, not back to the necessary design basis. You would be dealing with the efficiency of the plant on the basis of the environmental parameters rather than on the statistical parameters that were used in designing the plant.

DR. W.R. TROST

If I took that correctly, you're opting for the ambient ground parameter rather than the stack parameter, is that right?

MR. E.E. CUDBY

This is the ultimate...(?)

DR. W.R. TROST

You did get some information about the composition of the raw feed. I take it that this is the material that comes out of the ground?

MR. E.E. CUDBY

From the wells and the reservoir.

DR. W.R. TROST

Does it contain anything besides hydrogen sulphide, CO_2, and the hydrocarbons?

MR. E.E. CUDBY

May I direct that question to Mr. Newshouse, please?

DR. W.R. TROST

Yes.

MR. NEWSHOUSE

It contains about 12% nitrogen. If there's formation water produced, it's reinjected.

DR. W.R. TROST

Salt water?

MR. NEWSHOUSE

Yes, and of course, the gas is dehydrated before sale to the pipeline company.

DR. W.R. TROST

Do you ever have any problems at the well head?

MR. NEWSHOUSE

In producing?

DR. W.R. TROST

Right.

MR. NEWSHOUSE

There are always problems I guess, but no, they're dealt with.

DR. W.R. TROST

What kind of problems?

MR. NEWSHOUSE

Hydrate problems from time to time. This is when you essentially get freezing across a control valve or choke; problems of that nature.

DR. W.R. TROST

Do you have to add something at that stage, or is there a systematic way of handling that hydrate problem?

MR. NEWSHOUSE

Yes, usually methanol is used and it solves the problem.

DR. W.R. TROST

Is there ever any chance that at the well head there is apt to be a blockage or a break or a blow?

MR. NEWSHOUSE

Well, there is always this possibility.

DR. W.R. TROST

Does it happen? Has it happened?

MR. NEWSHOUSE

It hasn't happened in the sense that you're referring to. In terms of normal producing operations in this particular field, no.

DR. W.R. TROST

In cases of abnormal producing systems?

MR. NEWSHOUSE

You're getting to a point concerning the re-work of a well. That occurred over the last year to two years. A service rig was installing downhole safety valves at the request of the Energy Resources Board. Because of a severe wind the rig toppled over and broke the well head off, and there was acid gas flaring at that time. It was quickly ignited, and it was brought under control within a matter of hours.

DR. W.R. TROST

Now, you re-inject the production water. Is that right? There are no other liquids or other materials that you have to separate out prior. Is that right?

MR. NEWSHOUSE

That's right.

DR. W.R. TROST

You talk about the tail gas monitored continuously to insure the optimum performance of the three-stage Claus plants tail gas clean-up facilities. Would you tell us, please, what percentage of removal you get of the sulphur with a three-stage Claus?

MR. NEWSHOUSE

Between 96 1/2% and 97%.

DR. W.R. TROST

That of course meets the regulations as they are written now, does it?

MR. NEWSHOUSE

That exceeds the guidelines.

DR. W.R. TROST

What would be the guidelines for your plant?

MR. NEWSHOUSE

I believe it's 94 to 96.

DR. W.R. TROST

When you are operating then within these percentage recoveries, what is the sulphur product that isn't recovered? You're venting some remainder presumably?

MR. NEWSHOUSE

After treatment through the tail gas clean-up unit the most recent stack survey performed by the Energy Resources Conservation Board indicated that we were only emitting two and a half long tons of sulphur per day.

DR. W.R. TROST

Two and a half long tons of sulphur per day in what form?

MR. NEWSHOUSE

Sulphur dioxide.

DR. W.R. TROST

Do you get any other sulphur compounds? Do you get any carbonyl sulphur or carbon disulphide?

MR. NEWSHOUSE

A carbonyl sulphur, or COS, and CS_2, are minimal in this plant, very small quantities relative to what other plants produce.

DR. W.R. TROST

Concerning the run-off water before release under government sanction to the Red River to Red Deer River, water analysis tests are taken to assure that it is safe for disposal. What do those water analysis tests show?

MR. NEWSHOUSE

They show the BOD content, phenol content, hydrogen sulphide content, the COD and the total solids content.

DR. W.R. TROST

Now, presumably, these values, the values that you find are within the regulations. Can you give us an indication what the regulations are, say for phenol?

MR. NEWSHOUSE

I can't off the top of my head. I don't have that information available. It is contained in an approval from the Department of Health.

DR. W.R. TROST

Do you get some phenol test detection?

MR. NEWSHOUSE

If we did, it was only in trace amounts.

DR. W.R. TROST

Is your BOD count in the run-off water higher or lower than the river to which it's fed?

MR. NEWSHOUSE

We're restricted when we can release this water to the Red Deer River. It's restricted to the months of July and August, and I don't know what it is relative to the BOD content.

DR. W.R. TROST

At Pincher Creek one of the plants described a lagoon system, collecting system for their water run-off. They described a bioassay technique. Do you use a similar method?

MR. NEWSHOUSE

No, but the laboratories that do the tests have run these bioassay tests.

DR. W.R. TROST

Do you use fish?

MR. NEWSHOUSE

Yes.

DR. W.R. TROST

You describe operational upsets at the Nevi Operator's Committee Gas Plant that may occur from time to time. Do you have the community involved in any way in respect of their complaints and your attempts to settle them? Do you have anything like a community committee with whom you work?

MR. NEWSHOUSE

No, we don't have a committee as such. Discussions are held with them on a more individual basis, when and if they so desire.

DR. W.R. TROST

Do you have any program that is set up to look into the environmental effects that may or may not come from the emanations from the plant? Again, some companies have indicated to us that they do have such a program or are setting up such programs. Have you, or are you considering it?

MR. NEWSHOUSE

Not at this particular plant. We spent a considerable amount of money in the installation of tail gas clean-up facilities where other people have spent it trying to assess the levels of damage of sulphur dioxide and this sort of thing to the environment. In this particular instance which I might add is unique because of certain circumstances, money has been spent improving the recovery efficiencies.

DR. W.R. TROST

If you were to consider setting up such a program would you welcome input to such a program from the community that is having the problems?

MR. NEWSHOUSE

Yes, I think we would.

DR. W.R. TROST

Mr. Flook has already drawn attention to the statement that you suggest that the ambient air quality standards are already more than adequate. How can you be sure of that, if you haven't got such a program?

MR. E.E. CUDBY

This is a question of reviewing the literature, listening to the experts in the field; and from their point of view, indicating that the level is more than adequate.

DR. W.R. TROST

Even though you think that each plant is an unique problem and should be handled in a unique way, you haven't looked at what would therefore be the unique problem in your own environmental area.

MR. E.E. CUDBY

Only to the extent that we have not noticed any permanent damage having occurred in the area, which hasn't made it really realistic to go any further. If there was some apparent damage being done in the area, I'm sure that this would be undertaken.

DR. W.R. TROST

You say the responsibility for determining applicable sulphur gas plant efficiencies to meet these standards rightly belongs to the operator. Do you want to elaborate?

MR. E.E. CUDBY

Only to the extent that I think it's incumbent upon any particular company who is proposing some industrial entity to convince the regulatory authority that it meets all the conditions both for the regulatory authorities and for the company. If perchance, any regulatory authority feels in some areas the company doesn't meet what they believe to be sufficient, they would tell the company that they feel that some alternative might be considered. The company would presumably have the right to return and re-examine it.

DR. W.R.TROST

What is it specifically that you were reserving to the operator when you say that the responsibility for determining applicable sulphur gas plant efficiency to meet these standards rightly belongs to that operator?

MR. E.E. CUDBY

Well, for example the Energy Resources Conservation Board has a curve which uses a guideline for gas plants of particular sizes, throughput and conditions. It also talks in terms of only allowing certain amounts of sulphur up the stack. It seems that we have these two things that are impinging on each other. We have efficiency which we have to meet on the one hand, and we have a stack emission problem on the other. Sometimes it can be terribly frustrating if you do have a situation where you can reduce the plant throughput for some particular reason, but your efficiency essentially goes below what you're allowed in terms of that particular line, yet at the same time your sulphur at the stack is well within the limits.

If we have a stagnant plant that is designed and acceptable to the Board, it would almost seem that that is sufficient.

DR. W.R. TROST

You feel that sometimes you may be placed under mutually incompatible restraints?

MR. E.E. CUDBY

That's correct, sir.

DR. W.R. TROST

I'd like you to also elaborate a little bit on your statement that the unique situation should be taken into consideration when contemplating the imposition of standards. You can see how the difficulty is that in having flexible standards, you may lose the lot, or you may have a whole lot of standards. What is your thought as to what practically can be done to meet that uniqueness?

MR. E.E. CUDBY

Well, I think at the present time the Energy Resources Conservation Board has essentially approached this particular policy of uniqueness, and has attempted in many ways to solve each plant's problem individually. I think this should remain so. The danger that I see occurring is that when you get this so called line of efficiency standards then it starts to put a stereotyped aspect to the total thing which then loses uniqueness of each plant. I think that it would be much better to consider the uniqueness of plants under all conditions.

DR. W.R. TROST

But you feel that the approach of the Energy Resources Conservation Board and its sort of graded guidelines, satisfies at least some of your need there.

MR. E.E. CUDBY

It may, but it may not necessarily be that it should apply to all plants in all places.

DR. W.R. TROST

In other words, you think that it should even be more flexible, and more amenable to particular circumstances?

MR. E.E. CUDBY

This is correct. Within the standard set by the Department of the Environment and whatever considerations the Energy Resources Board deems to fit the case, in the particular circumstances.

DR. W.R. TROST

Recognizing that right now the sulphur is being stockpiled in part so was wheat stockpiled in its time. Is not the production of sulphur assuming that it will ultimately be sold? Does not sulphur production pay for itself and perhaps even make a return for the company at this time?

MR. NEWSHOUSE

No.

DR. W.R. TROST

Why not; because you're not selling it?

MR. NEWSHOUSE

...because we're selling it only in part,because we're selling it at distress prices. You also have to look at individual fields depending on the concentration of hydrogen sulphide in the gas. We have ownership in certain gas pales that contain high volumes of hydrogen sulphide that we have participated in the development of. We can see no economics in processing the gas because of the high sulphur content, the expensive processing facilities associated with that gas and the stockpiling resource that we cannot sell at this time. We don't foresee being able to sell for a long, long time.

DR. W.R. TROST

On stockpiling, the experience that the companies are having now, is it not different in kind than the farmers had with their wheat to a certain period? It's clear that the farmers weren't making money when they were piling it, but nevertheless that doesn't mean that it was an unprofitable operation in the long run. In a sense the fact that it is being stockpiled doesn't necessarily bear on the economics of the area except if you want to make calculations of a particular sort. It doesn't wipe out the market, it doesn't wipe out the value of the product.

There's some thought that it is a distress price because the marketing arrangements for sulphur are a little disorganized from the sellers' point of view. To what extent is the price below a profitable return on the operation of the sulphur recovery part of the plant?

MR. NEWSHOUSE

That is a difficult question to answer because I think every plant is different.

DR. W.R. TROST

I'm asking about yours.

MR. NEWSHOUSE

Sulphur is an involuntary by-product of the processing of natural gas, so to apply the cost of the processing or recovering of sulphur is a difficult exercise. I would be rather loathe to make a commitment at this point in terms of what it would cost.

DR. W.R. TROST

But it has been done, hasn't it?

MR. NEWSHOUSE

We've gone through exercises but it's very academic.

DR. W.R. TROST

Academic to the sense that you knew when you were making a profit on it?

MR. NEWSHOUSE

Well, it's part and parcel of your whole project. We look at it, we don't try and separate it. It's part of the project of economics; the sale of gas, the sale of sulphur,the sale of liquid hydrocarbons, all the by-products together.

DR. W.R. TROST

You can't give a very good answer?

MR. NEWSHOUSE

No, I can't.

A PRESENTATION BY THE ALBERTA FISH & GAME ASSOCIATION FOR CONSIDERATION AT THE ENVIRONMENTAL CONSERVATION AUTHORITY HEARINGS REGARDING POLLUTION FROM GAS PROCESSING PLANTS

Presented by: H. Lembicz

The Alberta Fish & Game Association with a membership of over 22,000 members, who are deeply concerned about pollution of our environment, offer the following information and suggestions. It is our intention to be of assistance to solve pollution problems therefore maintaining or upgrading the quality of our environment. We believe a quality environment is essential for a good life.

The writer has been concerned for many years about the apathetic and/or greedy behavior of some people who degrade our water, air and soil. In regards to the production of oil and gas I have observed trees and other plant life die or become crippled from mainly sulfur dioxide gases. I have witnessed two near fatalities from hydrogen sulfide gas. While visiting farmers in the affected areas around gas processing plants I have talked to farmers who have observed a changed health condition of livestock and plant life. Their concern was made known to government departments who sent out their experts to investigate and they reported no problems. The government recognized their experts, but failed to acknowledge that the farmer was considerably more acquainted with their livestock and plant life and an expert in the observation field. It is encouraging to note that our government is beginning to become aware that toxic pollutants are associated with gas processing plants. However with the fast expanding construction of gas processing plants greater effort must be made to keep abreast of their polluting habits.

Last year I brought to the attention of the Energy Resources Conservation Board the possibility of mercury being associated with the sulfur that was incinerated and emitted to the atmosphere from gas processing plants. Surveys were done for mercury on the incoming gas at a number of the plants. It is good to know that at some of the plants there was no evidence of mercury, but at others there was as much as 1.5 to 45 parts per billion by weight in the gas. This is regarded by the Board to be insignificant considering the maximum toleration level of 5 pounds per day allowed each plant in the United States. We believe it is not wise to disregard this amount of mercury being continually dispersed throughout the area. It may not be a problem in some areas, but what about areas where the mercury content now is great enough to seriously contaminate fish, bird life and other life. It must be remembered that a continual dispersal of acidic mercury could result in a dangerous buildup.

Our Association believes it is not possible to monitor all areas that may be subjected to higher than allowable content of sulfur dioxide during a calm atmosphere or pocketing concentrations. These situations would cause damage to flora and fauna. Quote from U. S. Department of Health Education, Environmental Health Service:

> "Low concentrations of sulfur dioxide can interfere with the growth and functioning of a plant without leaving visible injury. This injury may interfere with or reduce photosynthesis. Grain crops may suffer a reduction in yield, especially if crops are damaged by sulfur dioxide at blossom stage."

> "The cost of agricultural losses in the United States was recently estimated to be in the neighborhood of $500 million dollars annually. Losses to agronomic species in California alone are estimated to amount to $132 million, with a 50 percent loss in citrus fruit."

It may be argued that air pollutants in Alberta are not as great as in California, however we may be nearing an equal to California considering there are about 47 gas processing plants, flare pits, pollutants from other industries and large cities.

Quote from S. N. Nixon Ph.D Chief, Phytotoxicology Section, Air Management Branch, Ontario Department of the Environment:

> "Recent studies in Europe have revived the controversy, by reporting that reduction in growth and yield occured without visible markings on certain plants exposed to atmospheric $S\ O_2$ in the field... "Alfalfa, barley, endive and cotton were most sensitive... Buckwheat, red clover, trembling aspen, jack pine, eastern white pine, white birch and bracken fern were most sensitive... Vegetation is most susceptible to $S\ O_2$ during the active growth months of June, July and August."

Quote from the Science Council of Canada:

> "Most air pollution is local in character and can be controlled. In the Sudbury nickel and copper belt, for example, sulphur dioxide spewing from the smelters has damaged trees up to 30 miles away, stunted vegetation within a 720 square mile area and caused extreme changes in the acidity of water in lakes up to 50 miles away. There are now no fish in 33 lakes."

From the Red Deer Advocate:

> "Two biochemists from New York University reported laboratory evidence suggesting that sulphur dioxide, a major component of air pollution, can disrupt normal genetic mechanisms."

The corroding effect of hydrogen sulfide and sulfur dioxide gas on metals also deterioting effect on paints cannot be ignored.

Recently another threat to animals including mankind has been discovered by a United States Geological Survey. It was found that P C B (polychlorinated biphenyls) a chemical related to D D T was found in wide spread water courses and lakes. Air born dispersal is suspected. The Environmental Protection Agency has recommended a limit of 0.01 micrograms of P C B per litre of river and lake water. The Geological Survey study found concentrations ranging from 10 times to 100 times that level in river and lake water. P C B is a colorless chemical originating from pentanes such as benzene and methanes, a product of natural gas or coal. Other pollutants from gas processing plants are; carbonyl sulfide, carbon disulfide, selenium, lead, phenols, glycols, heavy hydrocarbons and mercaptans.

It is obvious that methods of disposing of gas processing wastes other than spewing them into our atmosphere must be found. The question arises, can we afford other methods? This question was thoroughly discussed at the 1966 Pollution of our Environment Conference in Montreal. The decision was: We cannot afford not to correct pollution problems.

Surveying the situation we strive to obtain industry because it stimulates employment and circulation of more money. Proper pollution control facilities would create extra construction and employment and circulate additional money. It may be that proper pollution control would slow down the development of our natural resources or may curtail an increasing flow of finances, which we have become accustomed to believe is essential to our happiness. Yet there is no proof that this expanding flow of money creates more happiness. If anything it is to the contrary.

Our Association suggests that every effort be made to stop spewing toxic pollutants to our atmosphere. The price we pay from the loss of agricultural production and loss of health and a quality environment may be much more than proper air pollution control facilities. We have the technical know how to do many things with natural gas and oil. Then it follows we can successfully stop this type of air pollution. It is being done on a small gas processing plant in the Big Bend Field by an iron sponge screen. This system or some similiar scheme should be used in all other gas processing plants.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

What of the inability of investigations set up by government to zero in on the problems which you have referred to which have resulted in negative results or no definite results? Would you care to comment on that?

MR. H. LEMBICZ

I talked to the farmers in the Nevis area that were having problems and they had told me that the Government sent out veterinarians and people from other departments who were involved in pollution. For some reason they would go away saying there is no problem, yet that department would know that things had changed. I think I could understand that part of the reason why there was not too much done about it was because it was very hard to tie it down to any specific reason why there was some change in the health of animal life or plant life in the area. There was some evidence that something was wrong; but for that man who made the observations and the tests to say that this gas processing plant is responsible he would have to prove it. We didn't really have the proof at that time, and I don't think he had enough support. I think at the present time in these investigations a technician in that field feels freer to present his observations because he knows there is going to be more support behind him, because the public interest has been aroused over the last about ten years. I think this is slowly generating to where we're going to get better analysis from the technicians of the problems that are happening. Also, I think the concern of the oil companies is greater too, and I find that the public is very concerned with what they're doing.

DR. S.B. SMITH

You stated you have witnessed two near fatalities. Are you suggesting that these two near fatalities are because of improper operation or were they accidents?

MR. H. LEMBICZ

I would say it is improper operation. I don't believe that even at that time our Oil Gas Conservation Board were putting on enough pressure to see that existing regulations at that time were carried out.

In one particular case on my farm, I happened to go down to the battery site by a producing well. The well was over the river bank, so it was a little hard to get down to the well, and quite a little piece of you had to go around to get down there. The flare pit had gone out. The chap that was hauling the oil away at that time didn't bother about getting the flare going again. He went on the top of the butt of the tank and lifted the lid so the hydrogen sulphate was rolling out of the top. I came down and saw this and I said, "Look, you'll have to shut that down or get that flare going", and he said, "Well, this isn't going to cause any problem". I said "That stuff will kill you". He laughed and said, "I've hauled oil out of the oil fields for a number of years and it's never affected me before". About two weeks later I was combining that same field, and that same man came up to me and said,"I just come up to thank you for telling me that stuff will kill you, because about a week ago I was loading up my truck and working around on a calm morning, an early morning. I was working around and loading the truck with oil; when it was full I climbed into the cab. I got just outside of the battery site, and I felt something going wrong. I was starting to pass out, and I remembered your words, 'that stuff will kill you'. I immediately threw the door open but I didn't crawl out, I fell out. If you don't believe it, look at that scar on my head where I hit the ground. If I'd have stayed in there a little longer I'd have passed out in the truck, because I think that stuff was right in the truck cab."

The other one was my neighbor to the north. He was building a fence around a battery site. He could smell the hydrogen sulphide quite strongly. This battery site wasn't too far from the house. He started to feel sick and started towards his home. He passed out on the lawn and his mother got him into the house, and revived him. What I'm trying to point out here is the careless way we have been handling production of our gas and oil in the past, and I think we're still carrying them out in a careless way to quite an extent. I believe that we'll find in the next number of years that we must find another means of controlling our emissions from gas processing plants other than spewing into the atmosphere. Surely there is some way of cleaning it on this Big Man area that I referred to, I haven't had an opportunity to find just what is going to take place. They are taking out hydrogen sulphate but they're not incinerating and putting it through a stack into the air. I think this is a step in the right direction, we should follow it up and try to see if it cannot be done in all other areas where we have sulphur dioxide.

It's been proven that we have mercury as well, and we have a number of other chemicals. I just mentioned about six or seven that possibly we don't know what their effects are upon our health, plant life and so forth. This PCD is just a recent thing that's been found, and it is far from being found out just how much damage it is doing. They already suspect some other damages and it's going to be with us a long time if it has the same qualities as DDT, which doesn't break down for a long period of time.

MR. W.A. FLOOK

Everybody here is concerned about achieving through these hearings as much information as possible regarding the direct cause and effect relationship between the gases that emerge from gas plants and the effects on human and plant life. You have observed trees and other plant life die or become crippled from mainly sulphur dioxide gases. Would you like to expand a little on that and let us know just how firm your evidence is that this was a straight cause and effect relationship.

MR. H. LEMBICZ

Well, I might say I am not a technician, but I have been interested in pollution for over twenty years and I am expert in observation. On my own farm with about four different battery sites, I have observed what is happening around the flare pits. I do know that trees around the fire pits that were far enough away that heat from the flares where they were burning oil at different times and gas was not reaching them, yet they died a distance away from the flare pits. I also observed the broad leaf plants especially getting sort of a dead fringe on the leaves. Closer in, again they weren't burnt by the flare pits, but they were dying. Another thing that I observed was the cattle. Some of these pits were in the pasture. I have never seen the cattle pasturing on them. As a matter of fact there wasn't much for them to eat around there. There was some grass but they would go on to the other part of the pasture, so there must have been something there that they didn't like. I've seen that in other areas too, throughout other gas or oil fields where there was sulphur hydrogen gas. In the Nevis area where I checked in on the well at the Chevron plant and the BA plant, I could see the same thing happening not too far from the plants. My observation told me that something was wrong with that plant life.

MR. W.A. FLOOK

You really haven't established a direct connection between the effects and sulphur dioxide. You have established a connection between something you have observed and the presence of a plant. The important thing is to establish an effect from the specific chemicals so that when you observe the effect you can reduce the presence of a chemical. Your statements seem to imply that you may have had some evidence of that nature which we would like very much to have, but obviously the statement was not intended to convey that.

MR. H. LEMBICZ

In other words, I cannot say what was causing this damage ...

MR. W.A. FLOOK

Other than it was something that came from the plant.

MR. H. LEMBICZ

It, in my opinion, must have come from the plant, otherwise it wouldn't have happened. I wouldn't say that it was sulphur dioxide, it might have been some other chemical; but it did come from that flare pit.

MR. W.A. FLOOK

That's a point I wanted to make, since you mentioned sulphur dioxide.

MR. H. LEMBICZ

Yes, it did come from the flare pit. I'm sure of that.

DR. W.R. TROST

Have you noticed any effect on the water systems on the creeks and the rivers that you think might be associated with this in any way?

MR. H. LEMBICZ

I have had tests made of some water coming from the BA gas processing plants at Nevis about ten years ago. I think they have remedied it quite a bit. The stream was running into the river, but they have drilled a deep well and are putting runoff down to an underground stratum where it isn't affecting the river anymore. This particular stream came from a flare pit which had quite a bit of water and effluent in it. It had run over and off into the river. The cooling water that came from the plant into the river was not bad at that time.
Another of the plants, Chevron, when I first investigated it, the effluent was running into a reservoir on a farmer's pasture. The cattle became ill and were not doing too well, and the calf crop was down. This same reservoir emptied into a creek that went to another farmer's yard, and then into the Red Deer River; and they were having problems as well. However, I understand that they have constructed

lagoons to take care of that situation.

I haven't been down to investigate these plants in recent years, and I was happy to hear that the representative from the BA or the Chevron plant say that they are not having many complaints recently. I know they have upgraded it quite considerably, patched up the facilities to stop pollutants; but possibly we should be going for something greater to stop spewing the pollutants into the atmosphere.

Submission presented by: A.E. Wigmore
Alberta Association of
Municipal Districts and
Counties

I represent the Alberta Association of Municipal Districts and Counties, and for that reason my emphasis will be on the economic effects. Firstly, as it affects individuals. I don't happen to live in the area that is affected, but you hear a great deal of what goes on around the County when you sit on a Council for twenty years. I happen to live in the County of Lacombe. I brought in an exhibit of some barbed wire. I see it has been cast into the shadow somewhat by someone who brought in a better exhibit, so I can just reinforce that this really does go on. I would like to make a suggestion, and that is that prior to the telephone going underground, you had one of the best indicators of physical damage that you could possibly have in the County. It is a standard product spread over the country and is a certain height above ground where it is not affected by livestock, snow drifts or grass, and that is your telephone lines. They deteriorated around these plants, and I think if an effort had been made you could have measured the extent and the degree of this deterioration quite simply. I would like to suggest that seeing that there is probably a surplus of telephone wire in the Province it wouldn't cost too much to put up little spans of telephone wire in the proximity of these plants. Then you could measure quite well, because this is reflected not only in barbed wire, but on machinery that is left out and tools that are left in the shops. I think that it would be reasonable if you could establish a reliable indicator of deterioration. Farmers could be paid compensation for a certain amount of depreciation on fences according to the way it is affected. This could be indicated by the telephone wire, and I think it is fairly reliable. The first telephone wire was put in my farm before I got there. It was installed in 1910 and when it was taken out two years ago, it had not rusted yet.

Now, the other effect is something that has not been mentioned so far, and that is marketability of certain property that is around the plants. It affects Counties and Municipal Districts and the improvement districts through their assessment. I have here a copy of a letter that was sent to us by the Red Deer Regional Planning Commission, regarding a certain proposed subdivision.* This subdivision was on land that was certainly below average for agriculture purposes, sandy and rolly, but it was ideally suited for country residences. There was a report from the Red Deer Health Unit on this proposed subdivision and one from the Energy Resources Conservaiton Board. This came through the Red Deer Regional Planning Commission to our Municipal Planning Committee. The Red Deer Health Unit cannot grant permission for the following reasons:

a. An oil well situated to the Northwest portion of this parcel will shortly be reactivated by the oil company as a salt water disposal well.
b. The high pressure pipeline running parallel with the south boundary of the quarter section will always be a potential health hazard.
c. The oil companies will not allow the placing of buildings, wells and sewage disposal sites over their right of way portions of land within the quarter section.
d. Highly offensive odours will always exist in the area.

The Energy Resources Conservation Board also expressed their concerns over the danger of an explosion and possible gas leaks which had been known to carry an oil spray in excess of one-half mile. It should also be noted that the gas that is produced with the oil from the well located on the quarter is highly toxic as well as explosive. The Energy Resources Conservation Board therefore recommended that the proposed subdivision not be approved, and listed the reasons. I am bringing this up not with the idea of a particular solution, but is seems to emphasize and underline the effect that this has on the community. It has an effect, an economic effect, that is a side effect of the health hazard that exists and is recognized by other people.

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* A photostat of the above mentioned letter is attached to this submission.

ED DEER REGIONAL PLANNING COMMISSION
4910 - 59 STREET RED DEER, ALBERTA

TELEPHONE: 346-3394

FILE No. 24/214

August 29, 1972

Mr. R. B. Robbins
County Commissioner
County of Lacombe #14
Lacombe, Alberta

Dear Sir:

Re: Proposed Subdivision-
Pt. S.W. ¼ 19-39-26-4

Enclosed is a sketch of the proposed subdivision which is located two miles east of the Village of Blackfalds and adjacent to a secondary road. The applicant proposes 12 parcels for use as country residential sites.

The soil is rated at #3 on our soil rating charts as pasture and woodlands and the land is zoned as agricultural under the County Zoning By-law, with country residential sites a conditional use.

We had referred the proposed subdivision to the Department of Highways, Red Deer Health Unit and Energy Resources Conservation Board, the latter two due to the existing oil well site, and their comments are as follows:

(1) Department of Highways
Although the site distance at the proposed intersection with the secondary road is limited to the west, they have no objections to the proposed subdivision.

(2) Red Deer Health Unit
Cannot grant permission for the following reasons:
(a) An oil well situated in the north-west portion of this parcel will shortly be re-activated by the oil company as a salt water disposal well.
(b) The high pressure pipe line running parallel with the south boundary of the quarter section 19 will always be a potential health hazard.

.../2

MEMBERS
CITY OF RED DEER - TOWN OF CARSTAIRS - TOWN OF CASTOR - TOWN OF CORONATION - TOWN OF DIDSBURY - TOWN OF INNISFAIL - TOWN OF LACOMBE
TOWN OF OLDS - TOWN OF ROCKY MOUNTAIN HOUSE - TOWN OF STETTLER - TOWN OF SUNDRE - TOWN OF SYLVAN LAKE - VILLAGE OF BENTLEY - VILLAGE OF BLACKFALDS
VILLAGE OF BOWDEN - VILLAGE OF CAROLINE - VILLAGE OF CREMONA VILLAGE OF ELNORA - VILLAGE OF PENHOLD - SUMMER VILLAGE OF GULL LAKE
SUMMER VILLAGE OF ROCHON SANDS - COUNTY OF LACOMBE No. 14 - COUNTY OF MOUNTAIN VIEW No. 17 - COUNTY OF PAINTEARTH No. 18 - COUNTY OF RED DEER No 23
COUNTY OF STETTLER No 6 - IMPROVEMENT DISTRICT No. 10

(c) The oil companies will not allow the placing of buildings, wells, sewage disposal sites, etc. over their right-of-way portions of land within quarter section 19.
(d) Highly offensive odours will always exist in the area.

(3) The Energy Resources Conservation Board:
Also expressed their concerns over the danger of an explosion and possible gas leaks which have been known to carry an oil spray in excess of one-half mile. It should also be noted that the gas that is produced with the oil from the well located on the quarter is highly toxic as well as explosive.

We are therefore recommending that the proposed subdivision not be approved for the above and for the following reasons:

(1) Section 50(a) of the Subdivision and Transfer Regulations states that land ~~may~~ be subdivided for country residences only on land that is situated not closer than one-half mile from a highway.

(2) Section 59 of the Regulations gives the permitted uses adjacent to a highway and country residential sites are not listed.

(3) Sections 13(g) and (h) of the Regulations - land may be subdivided only if it is suited or can be economically adapted to the purpose for which the subdivision is intended, having regard to:
    (g) the existing and prospective uses of land in the vicinity
    (h) such other matters which in the opinion of the approving authority may prejudice sound planning practice in the vicinity.

Please present the above mentioned proposed subdivision to the M.P.C. of the County and forward their recommendations.

Yours truly,

W. H. Fairbrother
Assistant Planner

WHF/jj
Encls.

QUESTIONING BY THE AUTHORITY

MR. W.A. FLOOK

You mentioned the value of the property. Have you any incidents that you know of where existing property has actually gone down in value specifically because it's located close to a gas plant or an oil well?

MR. A.E. WIGMORE

No recorded specific instances, because this came to our attention as this property had applied for subdivision, that is to be made into country residential parcels. Unless this comes to us, we don't really have an indication of the value of the property from the point of view of living.

MR. W.A. FLOOK

What that seems to indicate is that the planning commissions and the Energy Resources Conservation Board considered that that location was not suitable for that particular type of use. The question of property values is something a little bit different. If a property had an original value and could be expected to appreciate over a said period of time, and the presence of an oil field or a gas plant had the effect of reducing that value it would be something quite different. This purpose would be the same, the purpose for which the land is being used would not have changed.

MR. A.E. WIGMORE

In this case, of course, the land use was going to change; and the existence of this oil activity or development precluded this use for residential property, use for which it was ideally suited. It was low assessed land and not really suited to agriculture. In the course of municipal planning we tried to direct our country residential type of development onto the less productive areas of the county and tried to save the agricultural land for that purpose. If it was just pure grainland, it probably wouldn't have affected it, but for this purpose it certainly did.

MR. W.A. FLOOK

In other words, the answer is that you do not have any incidents where property has gone down in value as a result of the presence of a gas plant? No examples of it?

MR. A.E. WIGMORE

Not specific examples. All I could say is that from hearsay nobody would go out and pay as much for a house they expected to live in, even for farming purposes, if there is an oil well right next door. I think that nobody would contradict that who has ever lived in that country.

DR. W.R. TROST

Can you tell us in a general way what you know of the sale of land in areas adjacent to gas wells? Is there any trend or any indication that farmers do or do not try to move, or any indication that people do or do not try to come in?

MR. A.E.WIGMORE

Reports that come back to us for instance, such as this tell us certain farmers would sell out, but nobody wants to buy that land. I can say definitely there was very little turnover of land in those areas.

DR. W.R. TROST

Has there been any impact on the tax return to the municipality?

MR. A.E. WIGMORE

No, because the assessment is based on the productive potential of the land, which is grain. This I don't think was really appreciably affected. The residential value didn't enter into the picture at all.

CARSTAIRS VETERINARY CLINIC

DR. H. SUTMOLLER
& ASSOCIATES

BOX NO. 60
CARSTAIRS, ALBERTA

PHONE 337-3221

OBSERVATIONS ON THE EFFECT OF SULFUR ON THE SELENIUM LEVEL IN SOILS

Presented by Dr. H. Sutmoller, Veterinarian, Box 60, Carstairs, Alberta

My introduction may leave some people wondering what it has to do with the environmental effects of sulfur producing gas plants, but if you will bear with me for a short while I hope that everything will fall in place and can be discussed in its proper perspective.

A condition in bovine livestock, commonly called "White Muscle Disease" (WMD), has been diagnosed with increased frequency in the area east of the Alberta Foothills. This condition is caused by a deficiency of a trace mineral, Selenium, which has to be present in such minute amounts in the animal diet (min. 100 parts per billion), that it is classified as a trace mineral. The soil east of the Rocky Mountains is very low in Selenium and as a result all crops (hay, grains, grasses) are very low in Selenium. Analyses yielding less than 50 ppb are common.

Selenium deficiency in animals is characterized by poor skeletal muscle formation. Grossly in some cases the muscle has a pale appearance, hence the name "White muscle disease"; however this is only one manifestation of the disease and since most of the changes are microscopic and can not observed grossly, it is more proper to call this disease "Nutritional Muscular Dystrophy" (NMD). Clinically this condition in calves up to 3 - 4 months of age is characterized by stiffness, muscular weakness, and rapid death if the heart muscle is severely affected. Stillbirth of calves is common if the dams are on a low Selenium diet. The clinical effects of selenium deficiency are so widespread that it is common usage to refer to such conditions as "Selenium responsive", in other words treatment with selenium may produce dramatic results. Examples of such conditions are: chronic diarrhea, unthriftiness, abortions, infertility, degenerative heart conditions, hepatosis (liver degeneration). These conditions are difficult to recognize but can be of great economic importance because of their insidious nature.

The diagnosis of NMD is made with increased frequency and in the light of points raised later on in this discussion we can make two speculations:

The disease syndrome is more accurately diagnosed due to more intensive clinical examinations, better diagnostic techniques in the laboratory and more routine soil and plant analyses; or

There is an actual increase in the number of cases of Selenium related diseases.

SELENIUM AND SULFUR RELATIONSHIPS

Selenium occurs naturally in soils in varying quantities. In certain regions it is very abundant and when it becomes concentrated in certain plants, it may lead to toxic symptoms in livestock. Some of the early work done by scientists were attempts to reduce this toxic Selenium level. Sulfur was found to be inhibitory to Se (5). Many of these experiments were done under controlled laboratory conditions and had no practical application in the field. However it made scientists aware of the inhibitory relationship between S and Se. Both elements are chemically closely related and are essential in cell metabolism because of their involvement in synthesis and activation of cell enzyme systems. S substitutes easily for Se in biological systems (10). In the presence of abundant S the cell may take up S in preference to Selenium. If the problem is aggravated by low Se levels in the soil to start with, it is very likely that very little Se is absorbed in the plant. This inhibitory effect takes place as the plant extracts nutrients from the soil and in a lesser degree when the animal digests plants low in Se and relatively high in S. This inhibitory effect is well documented by workers in different parts of the world (3) (11) (10). Muth and co-workers (10) make the blunt observation that S interfered with Se metabolism and that this resulted in a Se deficiency in the plant and animal. Whanger and co-workers (14) in their experiments could not demonstrate a significant increase in NMD with dietary S supplementation, but conceded that there were more degenerative lesions in the hearts of experimental animals (lambs).

If this was the only phenomenon taking place one could simply state that too much sulfur in the soil or in the diet would be detrimental to Se absorption and utilization. However this is not the case. Most Se deficient soils are also low in S, whereas many soils high in Se are fortunately high in S. It is quite possible that the high level of S keeps the high level of Se in check, one of the reasons why Se toxicity is not of a more common occurrence on these soils. (7) (1)

Sulfur in proper amounts is just as important to plant and animal metabolism as any other element. S fertilizer applied to S and Se deficient soils has given very important increased yields in forage production. Often the Se level in the resulting greater quantity of forage drops considerably, but this is thought to be due to the plants competing for the small amount of Se available, not an inhibitory effect by the also small amount of S. This phenomenon has been termed "dilution". (13)

IMPORTANCE OF SULFUR DISCHARGED BY GASPLANTS

Four point five million tons of sulfur were produced in Alberta in 1971. (6) This represents approximately 95% of the actual S production, therefore roughly 237,000 tons of sulfur were discharged into the atmosphere through the incinerator stacks. Studies in Sweden (4) and in Alberta (12) have shown a high correlation between total S in the air and S in precipitation. Soil analyses established varying levels of S depending on distance from the source, prevailing winds and amount discharged. In Sweden annual deposition of S ranged from two to twelve pounds per acre over a large area. Limited sampling in Alberta around one sulfur extraction plant showed levels of annual precipitation of two to four pounds per acre.

DISCUSSION

An average yield of two tons per acre of legume hay requires approximately eight pounds of S for optimum production. This amount should be applied to the soil by the farmer in the form of S-containing fertilizer. One may wonder therefore if the farmer is getting his S free of charge through precipitation why objections are raised at all. Here we come to the heart of the problem of pollution. Consider the following factors, which I believe are pertinent and the reason why I believe that S should not be freely discharged into the atmosphere:

1. S is only beneficial to S deficient soils, and in any other type of soil it is surplus and undesirable. Its effect on Se has already been pointed out.
2. Farmers knowing what their soil requires will put in controlled amounts of nutrients through fertilizer. The amount of S through precipitation is uncontrolled, resulting in wide variations. The confusion has reached such proportions that many farmers who should be using S fertilizer refuse to do so in the belief that enough or too much S is already present in their soils.
3. The growth stimulation encountered in S deficient soils after S application has only been proven for legume crops. All papers reviewed mention only "legume" response and to my knowledge the growth response to cereals, grasses and pasture remains uncertain.
4. If we agree that ten pounds of S per acre is required for optimum legume growth it means that 237,000 tons discharged annually (and this figure is likely to go up with increased gas consumption) would be sufficient for approximately 74,000 square miles. We may assume that this amount returns to earth over a much larger area, but there is a grave risk that it may accumulate in some locations.
5. One may argue that since S is beneficial to certain soils it may be economically advantageous to treat the resulting conditions caused by Se deficiencies (8). This is in my opinion scientifically unsound reasoning. It places an unfair burden on the livestock owner and makes him entirely dependent on the use of therapeutic levels of selenium. Usage of Se is not without risks and at present is only available on a prescription basis. Muth (15) mentions that Se is classified as a carcinogen, although

Frost (2) has published work to the contrary.

We must also point out again that many Se responsive conditions go unnoticed.

Money (9) published some startling work relating Se deficiency to "sudden death" in infants. The muscular dystrophy in humans is linked to a hereditary condition rather than a nutritional factor.

IN SUMMARY I like to point out that sufficient evidence exists linking sulfur accumulation with Se deficiencies, which has far reaching effects on plant and animal life.

It has also been established that S from S producing gas plants returns to earth, how much and where is open to speculation. There is a great need for extensive soil sampling and analyses throughout the province and relate present findings to values found ten to fifteen years ago before S extraction reached major proportions. We do not have sufficient information on the long range effects of high soil S on Se levels in the plant.

The whole problem warrants immediate and extensive research. The knowledge gained will be of tremendous importance in understanding S and Se metabolism, soil and forage management, and related animal (and maybe human) diseases.

In the meantime it would be inexcusable to allow discharge of a product which may have wide ranging and long lasting effect on agricultural and animal husbandry.

We have to keep in mind that oil and gas are exhaustible resources, but that the soil has been the producer of foodstuff for many centuries and only through our care will continue to do so for the next centuries.

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Report on examination of 47 head of yearling heifers at the farm of Mr. Mac Turnbull, Cremona, Alberta, Land location:

History:

Prior to August 7th, 1971 these cattle were running out on a hay field on high ground and on a low lying native pasture surrounding the farm buildings. They were purchased in the fall of 1970 and had made satisfactory gains without any outbreaks of respiratory disease. Approximately August 7th, the Turnbulls noticed a persistent cough in the majority of the cattle and the next day Mrs. Turnbull phoned me to report an animal in respiratory distress, apparently gasping for air. However, within a few hours she phoned back that a visit was not necessary because the animal had spontaneously recovered. On the 14th an animal was found dead but because of the summer temperature it was unfit for a postmortem examination. On August 16th I made a complete clinical examination of the Turnbull cattle.

Clinical Examination

All cattle had a persistent cough especially after mild exercise. Nine animals out of 45 head were selected because they showed a general poor condition and lassitude. Rectal temperature ranged from normal 101.5 F to 103.5F. Chest auscultation revealed dry crackling sounds over most of the lung area and moist rales in the area of the bronchi.

Diagnosis

Pulmonary emphysema. (bovine asthma).
Infectious disease such as pasteurellosis (shipping fever) and bovine rhinotracheitis (I.B.R.) were relevant on the basis of low temperature readings, absence of nasal discharge, lack of previous exposure.

Treatment

Antihistamines, cortisones, antibiotics. Outcome: relatively satisfactory. Some of the most severely affected animals recovered rather well although a general loss of weight was noticed in all of the animals. Fecal examinations for lungworm larvae and eggs were negative. Nasal swabs were also submitted with negative results.

Speculations as to the cause of this outbreak of P.E.

This condition in cattle is quite commonly seen following the ingestion of allerg occurring in certain types of hay, straw, nativea and tame pasture, grain cover crop pasture, and usually follows a precipitation which stimulates fresh and lush growth. This did not occur during August in the Cremona area.

Of secondary importance as causes of P.E. are: exposure to lungworm larvae and inhalation of allergins and irritants such as hay and straw dust, gravel road dust, fumes and gases. The Turnbulls have reported strong gaslike odors at approximately the time when these animals bacame sick and off and on from then on.

In the absence of other possible causes of Pulmonary emphysema we must consider the strong possibility of air pollution as a cause in this outbreak. The condition of the low lying area may favor a higher concentration of pollutants than elsewhere. It is my recommendation that all obscure cattle diseases and fatalities be thoroughly investigated. Prompt reporting and accurate record keeping are very important in this respect. The assistance of an independent and impartial government agency is solicited.

H. Sutmoller, D.V.M.

Distribution:
Mr. & Mrs. M. Turnbull, Cremona, Alberta.
Mr. George Cameron, Cremona, Alberta.
Mr. M. McBain, Cremona, Alberta.
Mr. R. Vilnook, Energy Resources Conservation Board, Red Deer, Alberta.
Department of the Environment, Edmonton, Alberta.
Mr. R. Clark, M.L.A. Carstairs, Alberta.
File.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Dr. Sutmoller, the white muscle disease or muscular dystrophy you state has been diagnosed with increased frequency in the area east of the Alberta foothills. Can you give us some estimate of the frequency; and secondly, can you tell me if anything is going on in agricultural physiology labs or related research institutions which can give any more definition to the problem - some kind of quantitativeness per threshold which you don't metnion here. You don't mention the threshold levels. Presumably they may be in the literature; but I am concerned that what is the frequency of this dystrophy condition, and secondly, what experiments to your knowledge are going on in veterinarian institutions to quantify it?

DR. H. SUTMOLLER

Research is quite extensive in this particular area mainly because it doesn't have application to animal diseases only. The basic research in sulphur metabolism and selenium metabolism has a lot of application in other scientific fields as well, and I have given you quite a list of references at the end of my submission. This is only a very partial list of references that I have been able to accumulate. There have been textbooks written on this particular relationship. I'm afraid I haven't made an extensive study of those. I can only say about my own experiences in muscular dystrophic conditions in cattle. It was about six years ago we were starting to diagnose the first cases, and we have done so with increased frequency. Also, I think the severity of the condition is becoming more apparent. You are asking me about the incidence of the disease in my area, I would say that there are about 50% of the farms in the western portion of my practice that have to supplement their animal feeds with selenium, either in the form of direct supplementation in the feed or by injection into the animal. As I said, the disease is most severely manifested in young new-born calves, and for this reason many livestock owners will inject calves as soon as they are born. I believe this may give you some indication of the severity of the problem. If they don't they will lose calves. If they do then of course it is an extra burden on them. Most people are living with this condition now. I don't think you have to misinterpret my remarks. I don't think that sulphur is entirely to blame for all the cases of selenium deficiency that we have diagnosed; but there is a definite relationship between the two, and I feel this warrants some extensive examination, some research.

DR. S.B. SMITH

What about the possibility of white muscle disease in wild ungulates? Do you know whether there are any data available?

DR. H. SUTMOLLER

I have seen no reports on that.

MR. W.A. FLOOK

You imply, if I understand you correctly, the incident of muscular dystrophy in cattle can be used as an indicator, cattle can become an indicator organism for selenium deficiency in soil. By the same token, you state that the soil in the eastern part of the Rockies and to the east of the Rockies is deficient to the extent of about half the adequate amounts of selenium; so that in fact these symptoms that indicate selenium deficiency must have been present all along. Because of the fact that sulphur is now in competition with selenium, I fail to see how it really alters the situation since you are competing for an inadequate supply of selenium anyway. Perhaps you could explain this a little better to me.

DR. H. SUTMOLLER

I think you have to recognize that livestock production and forest production in Alberta has become very intensified. In other words, there is greater competition for the available nutrients, we are trying to extract more from the soil, we are trying to make our animals gain that much faster. It's very recently that the farmer has been getting about as much for his finished product as he was thirty years ago, except that he is becoming so efficient that he can actually maintain this price structure. I think this gives you an indication that selenium deficiency and any other deficiency for that matter will be of a greater importance in the future unless steps are taken to correct these deficiencies. I think we are going about this in a backwards fashion. We are aggravating the deficiency. There is good indication that sulphurs are inhibitory to selenium and therefore making deficiency that much more common an occurrence.

MR. W.A. FLOOK

It's correct that the initial competition between sulphur and selenium occurs at the plant root presumably.

DR. H. SUTMOLLER

Yes, very much so.

MR. W.A. FLOOK

The second competition occurs in the animal when it ingests the selenium deficient vegetables. Whether it's cattle or humans, the symptoms of selenium deficiency should show up?

DR. H. SUTMOLLER

It could sir, yes.

MR. W.A. FLOOK

Do you know if there has been an increase in selenium deficiency symptoms in human beings as well?

DR. H. SUTMOLLER

No, sir, I cannot comment on that. I haven't seen any reports to that effect.

MR. W.A. FLOOK

Is it likely that this could be widespread without people being generally aware of it?

DR. H. SUTMOLLER

It could be, and this is one of the reasons why I injected this reference from New Zealand of a medical research team which has shown that they have some reason to believe that sudden deaths in infants, these obscure crib deaths as they are called, may have some relationship to selenium deficiency. New Zealand is one of the areas that has the biggest problem of selenium deficiency. Their soil is of a volcanic nature I believe and has a high sulphur level.

MR. W.A. FLOOK

I think the thing that I am trying to zero in on is that if, in fact, people are living in an environment which shares a debilitating characteristic such as this is, then you would expect that the result of this would be literally epidemic; not three or four cases per year, but hundreds.

DR. H. SUTMOLLER

Yes.

MR. W.A. FLOOK

Is that in fact what is happening?

DR. H. SUTMOLLER

Yes, and it's great in the western part of the province.

DR. W.R. TROST

I take it that you are suggesting, because sulphur and selenium have many chemical similarities, that sulphur is able to replace selenium in some of its physiological functions; and consequently what might be called a selenium deficiency disease occurs. Furthermore, selenium is naturally deficient in the surface areas of the province, and consequently when extra sulphur is fed out, it is able to act in this repressive way by replacing selenium through its chemical similarity with the selenium element. Since selenium, like sulphur, forms volatile hydrogen compounds; and since selenium, like sulphur, forms volatile oxide; and since selenium, like sulphur forms acids H_2S, CO_4 and H_2S, SO_4 and so on; there is some reason to feel that selenium may follow sulphur even in its presence underground and its deliverance to the soils. Do you know if there is a selenium component in the sulphurs that are extracted from the gas plants?

DR. H. SUTMOLLER

I can't comment on that except that I read in Dr. Klemm's report that selenium is being discharged in minute amounts through the incinerators. I wasn't aware of that. But like any other element, it is quite possible that there could be minute traces of any element in any discharge. I don't believe that the amount of selenium discharged through the incinerator is of any great importance. I don't believe it could either supplement the selenium level in the soil or reach toxic proportions.

DR. W.R. TROST

I see in your report that selenium can be in excess, toxic; and deficient and also toxic. Even if selenium were being delivered in some minor part with sulphur from the sulphur extraction process, which wouldn't be unusual since they are chemically so similar; your suggestion is that the extra amount of sulphur that was produced would still act in a repressive and substituted capacity for that selenium.

DR. H. SUTMOLLER

Yes, sir, I believe that would be a conclusion.

DR. W.R. TROST

If you would, Dr. Sutmoller, please review the nature of the selenium deficiencies in animals that you were drawing our attention to.

DR. H. SUTMOLLER

The most obvious manifestation is in skeletal and cardiac muscle formation, so we see it in the young fast-growing animal of up to three to four months of age. Attacks of muscular dystrophy are usually associated with exercise, with sudden exercise it will show up; laying stiff and sudden death is possible when the heart is severely affected.
The other problem that I run into with great frequency and which alarms me, is something we didn't use to run into; a lot of calves are born with poor muscle formation and actually we are faced with a lot of stillbirth. We can't really call them abortions, they are fetuses of the calves carried to term, nine to nine and a half months. They are born either too weak or dead, and the weak calves are very difficult to revive and as a rule a good number of them die. I believe, though, there is one aspect of this condition that is not very well documented in the literature. Ten or twelve years ago when I graduated from college, this condition was not taught to us in that respect. I think it is fairly common that veterinarians in this part of the province make this observation, but very little research has been done in this particular case.

DR. W.R. TROST

The conditions that you describe have been established clinically to the satisfaction of veterinarians as being due to selenium deficiency?

DR. H. SUTMOLLER

Yes, the changes observed in the muscle and heart of these stillborn calves have been checked by pathologists in veterinary labs and those signs and patholgoical changes are consistent with diagnosis of nutritional muscular dystrophy.

DR. W.R. TROST

Have the properties of sulphur replacing selenium from the physiological processes and thus leading to selenium deficiency artificially, as it were, also been clinically proven to the satisfaction of veterinarians?

DR. H. SUTMOLLER

Yes, there have been some experiments done. There is conflicting evidence there. I would say the majority of the work would prove that adding sulphur in significant amounts to an animal's diet will suppress the selenium, even if it is present, in normally sufficient amounts so that the animal will show up with signs of muscular dystrophy. The only other reference that I quoted was one that said that they could not see clinical signs of the disease but they did concede that there were significant increases in their lesions in the hearts of these experimental animals after they were sacrificed. I think this would have to prove that there is certainly a great correlation between the amount of sulphur that the animal is exposed to and the selenium in its diet.

DR. W.R. TROST

In your own practice and that of your colleagues, do you have evidence of the appearance of these kinds of diseases in animals that you have been exposed to?

DR. H. SUTMOLLER

I don't think you can draw the conclusion from what I have said that in my practice I have proved that sulphur is to be incriminated. I believe that in some of the discussions that were presented this afternoon that too much emphasis is placed on who has to submit proof here. The person that is registering a complaint has to come ahead with all the scientific evidence and prove that his wire is rusted or that his animals are getting sick. I believe there is a great need here for a reverse process where the admission, the proof of innocence has to rest with the person or the company that has come in after the farmer. Whatever industry, whether it is oil or any manufacturing industry, I believe this is a philosophy that you will have to get away from. The burden of proof should not rest with the person that is making the complaint. He is not, in most cases, in any position to make this proof.

DR. W.R. TROST

I think you are making a good point, but it doesn't, in fact, apply to yourself?

DR. H. SUTMOLLER

Yes, I'm in the same position. I cannot submit proof of everything that I see in my practice.

DR. W.R. TROST

I did want to have the two things made clear here;that you have had, and presumably your colleagues have had, experience of these diseases in your practice.

DR. H. SUTMOLLER

Yes, very much so.

DR. W.R. TROST

Have you had the opportunity to make any correlation between the incidence of these diseases and areas where sulphur was being disseminated in the atmosphere in some form or other.

DR. H. SUTMOLLER

I can't say. We have diagnosed this disease most frequently in the western portion of my practice, but we used to draw an arbitrary line through the province and say, well, selenium deficiency only occurs west of the No. 2 Highway, and east, not very common. This still holds true in many cases, but it is starting to show up, a good number of cases, in the eastern part of the province as well. Certainly in my area, I straddle the No. 2 Highway, I could not make this sort of comparison; and there are enough sulphur producing plants in my immediate vicinity that could certainly have some effect on my area.

DR. W.R. TROST

In a high sulphur situation, do I understand correctly that selenium can be fed to the animals in such a way as to relieve the selenium deficiency?

DR. H. SUTMOLLER

Yes, this can be done, as long as you know how much the animal needs. Selenium is not excessively toxic but it is certainly a product that is not without some risk when it's being fed. I do believe it is possibly but like I have pointed out, I don't believe this is the right way of going about it.

DR. W.R. TROST

Do you wish to draw attention to a situation that you think may have particular significances in it requiring research in particular directions so that the problems can be clarified?

DR. H. SUTMOLLER

Yes sir, I believe my submission points out that there is some very distinct relationship between sulphur and selenium. The amount of sulphur that is being discharged is, in my opinion, a significant amount that could have an affect on the mineral balance of our soil.

I believe that it is always easier to prevent a thing than to wait for something to reach proportions where you can't do anything about is any more. The time has come now to investigate these reports and direct research to these problem areas.

DR. W.R. TROST

Can you give us a rough idea as to how many cases of this sort you have had in your own practice?

DR. H. SUTMOLLER

I don't even know how many cases I treat in a year, so the only thing I can say is that the typical disease may be in the instance of say 5% of the total case load. I think you also have to recognize that a lot of these conditions don't follow the regular pattern; this condition can occur in calves even before they are born. So many other conditions possibly have still to be discovered. I have pointed out, too, a wide range of conditons; mostly chronic conditions such as unthriftiness, chronic diarrhea, and infertility.

DR. W.R. TROST

Is infertility involved, partly from stillbirths?

DR. H. SUTMOLLER

Yes, there have been reports that selenium deficiency will in effect, reduce the conception rate.

DR. S.B. SMITH

I am given to understand that when wild or domestic ungulates change their diet, for instance from dried diets in the winter to a green diet, that there is some possibility of strain on these animals in the late spring. If an animal is suffering or being debilitated by some respiratory ailment because of a pollutant or something of that nature, is there any possibility that a change in diet or some strain will be intensified by this chronic condition? Is this common in livestock?

DR. H. SUTMOLLER

No, I would say that it is the other way around. We see that when this change in diet that you are referring to usually affects healthy animals they develop a chronic or an acute ailment. I believe I have interpreted your remarks by saying the animal is debilitated and then a change in diet will aggravate the condition.

DR. S.B. SMITH

I wondered if it would, because it is more common for stock to change diet in the spring.

DR. H. SUTMOLLER

No, this is not my experience. The cases of emphysema we usually see are a result of change in diet occurring in late summer and fall.

DR. S.B. SMITH

What about the feeding of cattle, horses or livestock dry foods, dusty hay, this type of thing? Does this have any effect?

DR. H. SUTMOLLER

Yes, this is another common cause of emphysema; but is usually occurs on an individual basis. You don't see a massive outbreak of emphysema when you are feeding dusty hay, it's just usually a few animals. The cases of emphysema that occur as a result of dietary changes are usually more pronounced and a greater number of animals are involved. The same thing holds for cases that I believe are due to airborne pollutants.

MR. W.A. FLOOK

In other words, there are at least three possibilities here that can result in emphysema in cattle; change of diet, dusty fodder and airborne pollutants.

DR. H. SUTMOLLER

Yes. Of course animals are prone to parasites in the lung tissue also. Lung worm infestation in cattle is a very common cause of emphysema.

MR. W.A. FLOOK

In fact, without a very, very accurate case history it must be very difficult to determine what the cause of emphysema was.

DR. W.R. TROST

If a farmer came to you with an animal that was suffering from emphysema, and were to ask you to diagnose what the cause of the emphysema was, could you do it?

DR. H. SUTMOLLER

I would flatly refuse to make a statement as to the etiology of this condition. I would go through the usual routine of eliminating some of the most obvious causes. I would question him about the diet, check for parasites, check for viral agents. Yet, the problem is if you do not isolate any one of these agents, parasite or virus or bacteria, it still doesn't rule out the possibility that they could have been there at one time or another. In animal diseases we are severely handicapped by the fact that animals are brought by the owner, it's not the patient that comes to the doctor. It's the owner bringing the patient. The problem here is that we are, we can't question the patient so we have to base this entirely on clinical observation. A great deal of our diagnosis also has to do with taking of history and consulting with the owner as to what he has seen and what he has done that could have possibly started this condition in the first place. There's nothing more difficult than to get the truth out of a person, you know.

DR. W.R. TROST

The path forward, if one were to attempt to do research to establish cause and effect in a case like this, is maybe a matter of statistical analysis seeking positive correlations with this or that causative effect.

DR. H. SUTMOLLER

That's a start, yes; but, as has been mentioned before, these ailments haven't even been diagnosed in human beings. Even medical doctors have problems relating human conditions to some of the things we've been talking about. I think veterinarians are that much more handicapped in coming to a conclusion. Where did this all start? What is the cause? Especially in a problem like emphysema. There are too many causes that could result in emphysema.

GULF OIL CANADA LIMITED

Submission to the
Environment Conservation Authority

The Environmental Effects
Of The Operation of Sulphur
Extraction Gas Plants in Alberta

Presented At
Red Deer, Alberta
October 5, 1972

Presented by: R. E. Pauls

Gulf Oil Canada Limited supports the brief submitted by the Canadian Petroleum Association. The recommendation by the C.P.A. that the Department of the Environment in conjunction with industry be responsible for developing future Ambient Air Quality Standards in accordance with scientifically established criteria, is fully in keeping with Gulf Oil Canada's corporate policy on environmental conservation.

Gulf Oil Canada's Environmental Affairs Policy is:

1. Gulf Oil Canada Limited recognizes its community obligation to preserve the environment by minimizing emission and noise at all its operations--meeting all regulatory requirements and exceeding them wherever feasible.
2. The Company will co-operate with other industries, associations and/or governments in surveying existing pollution levels, with particular reference to Gulf Canada installations; and will assist in establishing realistic maximum allowable levels and programs to achieve or better them.
3. The Company will actively support the investigation of methods to reduce any pollution caused by the use of its products, and will endeavour to supply customers with products that will minimize pollution.
4. The Corporate vehicle for co-ordinating pollution control activities of operating departments and affiliates is the Environmental Affairs Committee, which has the prime responsibility for contact with government agencies in these matters.

5. The Committee will ensure that internal and external communications are utilized to keep employees, government agencies and the general public advised of significant progress in Gulf Canada's pollution control program.

6. The work of the Committee does not relieve operating management of its responsibilities in the field of pollution control, which include the training of employees in the importance of, and procedures for, clean operation.

7. Departmental and affiliated company management are expected to establish good rapport with local officials and other industries in demonstrating the Company's willingness to co-operate in pollution control matters. The Committee shall be kept fully informed of all pertinent discussions on this subject.

8. In order that duplication of effort may be avoided, and Company-wide experience brought to bear upon pollution control matters, operating management is expected to advise the Committee promptly of all relevant developments in their operations.

9. All new projects, whether or not directly concerned with pollution control installations, procedures or research studies, will be brought to the attention of the Committee early in the planning stage. The Committee will advise on the scope and form of technical facilities, surveys and operating procedures required to ensure conformance with Federal, Provincial and Municipal conservation regulations prior to the project proceeding to the construction or installation stage.

Gulf's Environmental Affairs Policy is implemented at all levels of operations throughout the many facets of this integrated oil company. Such a clear-cut program goes far beyond merely paying lip service to expressions of environmental concern. Gulf Canada's program, in fact, ensures that a healthy regard for a clean and safe operation results in responsible actions on the part of all employees.

The company-wide pollution prevention program is co-ordinated by an Environmental Affairs Committee responsible to the company's senior executive. Significantly, this Committee is headed by the Corporate Medical Director, Dr. J. D. Lovering, a clear manifestation of the company's responsible attitude, in recognizing that "human welfare " is the ultimate consideration in all its many environmental programs. In addition the Environmental Affairs Committee includes highly trained personnel from the Research and Development Division, as well as representatives from all the operating departments which include Exploration and Production, Refining, Marketing, Chemicals and Supply and Transportation.

It should be noted that in Alberta, 1961 was the first date of specific governmental Air Pollution Regulations for gas plants. However, the company on its own initiative instituted its own air pollution monitoring program as early as 1957. The five-point program included:

(1) identification of suspected sources of contamination.

(2) resolution of the extent and intensity of emissions.

(3) determination of short-period peaks.

(4) continuous meteorological studies.

(5) detailed studies on a 24-hour basis of critical areas as defined by general trend studies.

Similar programs were established at other Gulf plants as they began operations. As a result of Gulf Canada's experience with these monitoring programs, corrective measures were taken where indicated in order to further protect the environment and our neighbors. The company has continually pursued this course of responsible action, by a voluntary acceptance of our community obligations. It is interesting to note that in 1961 when the Air Pollution Regulations were implemented, its plants were operating substantially within the limits as set by the Regulations.

Gulf Canada's experience with Sulphur Recovery Plants is not limited to its gas plants on the plains and foothills of Alberta. At its refineries, sulphur recovery units have been installed to recover the relatively small quantities of sulphur dioxide which, if discharged in such densely populated urban centers as Vancouver, Toronto, Edmonton and Montreal, would constitute a potential environmental problem. The Refinery sulphur plants are small by Alberta gas plant standards (35 - 40 LT/D), however, they provide excellent pilot plant or test facilities for its Research and Development personnel. Through the combination of Gulf's Research facilities at Sheridan Park, Toronto, and the nearby field facilities of the Clarkson Refinery, the company's air pollution task force was established which developed the Gulf "Sulphur Plant Analytical Conversion Efficiency" Program, commonly referred to as "SPACE". In the SPACE program a Process Gas Chromatograph with associated instruments continuously measures each step of the sulphur plant process. With the aid of modern computing machines, the data is printed instantaneously and the operating staff adjusts the plant operating conditions to obtain maximum efficiency. In complying with the Department of Environment's request for continuous Sulphur Incinerator Stack Monitoring, Gulf Canada elected to use Process Gas Chromatographs and multiple point flow sensors instead of the commercially available single point flow monitors and component analyzers. This monitoring equipment has proven to be very practical and is one of the first valid continuous measuring instruments of stack emissions. Through such intensive "on-line" studies, Gulf Canada has significantly reduced both the number and intensity of plant upsets and unscheduled shutdowns and increased plant operating efficiencies.

In conclusion Gulf Canada submits that the research carried out by industry and the scientific resources available to industry has permitted industry to live within the limits set by the government and should be recognized. In addition, Gulf Canada submits that the standards for air quality as presently established by the Alberta and Federal authorities ensure the protection of the environment and, therefore, these standards need no further modification.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

You state that the committee will ensure the utmost in communications with several entities, including the general public. Do you have, in the areas where Gulf operates plants, any local committees or citizens' groups which deal directly with the plant management?

MR. R.E. PAULS

Not citizens' groups.

DR. S.B. SMITH

Do you think these might be used? Do you think there is any efficacy in establishing contact with groups of people, rather than just individuals over the area covered by the plant?

MR. R.E. PAULS

There is a possibility that this would increase communication, and increased communication is beneficial in any case. We don't want to relieve the operating management of their responsibilities, and we feel that one of the responsibilities of the operating management is to ensure that the public in his locale is informed of his operations. They do this by having open houses, going to the students and telling them about the operation, and offering this kind of service. We don't, in fact, have committees of citizens with the plant but we feel that we try to keep them informed as much as we can. Yes, it may be of benefit, yes.

DR. S.B. SMITH

Dr. Klemm and others have mentioned that the plants are all highly technologically intensive, they have got all sorts of very sophisticated equipment to try and help run these operations. Yet the machine presumably is only as good as the man who turns the switch, do you place great reliance then in the proper running of these plants by the staff in the plant?

MR. R.E. PAULS

Yes, we feel that our staff has to be very confident and well trained, and we will not let a plant be run by people that are not confident.

DR. S.B. SMITH

Is it at all levels, supervisory as well as lower?

MR. R.E. PAULS

Supervisory as well. A lot of our training programs are 'in plant' training programs, by the employees to other employees. New employees start at the bottom of the list so to speak, and then they are trained. We actually take them off shift, you might say, and make them extra employees on a shift where they are actually trained. We think that this is very important.

DR. S.B. SMITH

The last six words of your submission say, with reference to air quality standards as presently established, "these standards need no further modification". Do you really think then that the problems of operating these plants as far as air pollution is concerned, are entirely solved?

MR. R.E. PAULS

As I stated, we feel that the air quality standards as established by the Federal and Alberta authorities ensure the protection; they are set by experts. We therefore feel they do not need further modification. It's a very complicated subject, as Dr. Sutmoller indicated, diagnosing diseases in animals. We know it is very complicated, and if it should show that they do need modification Gulf Canada is prepared to. We would like to be involved in this.

DR. S.B. SMITH

Would you rather go the route then of perhaps intensifying co-operative research rather than altering standards now? Is this what you are suggesting?

MR. R.E. PAULS

Yes, I think that would be a better route as far as Gulf Canada is concerned. A co-operative research or a co-operative effort between government and industry; both in the research and in standards that are worked there today.

DR. W.R. TROST

Have you now an active research program aimed at evaluating the environmental effects of the emanations and activities associated with a sulphur extraction gas plant? The Shell program would be a reasonable example.

MR. R.E. PAULS

No, we do not have.

DR. W.R. TROST

Are you contemplating one?

MR. R.E. PAULS

We are. As I indicated, in Pincher Creek we are very interested in the Shell program, and intend to be involved with it, and certainly if it looks like there is headway to be made there, we are definitely interested in it.

DR. W.R. TROST

The feasibility that companies would co-operate in environmental effects research in the Pincher Creek district is almost possible since one company has already begun certain programs of study on something that hasn't really been given so much attention up to date; the actual effect of these effluents on the environment that come from the plant. Most of the attention is being paid to emission levels or technology associated with control, but hardly any to the actual effects on the environment of these emanations and materials, whether in the air, the water or the ground.

MR. R.E. PAULS

The C.P.A. brief has several attachments with it which were made by Dr. Kapps. We started an air pollution monitoring program as early as 1957. At that time we were faced with running the plant when there were no regulations so to speak; and we sought out experts such as Dr. Kapps, and looked at smelters where there had been some experience, and some of his work is still continuing for us as well as other members of the Association. He has made studies in the Pincher Creek area on regular periods of time in order to determine the effects on foliage. I don't have those studies here with me today, but I know that they are available.

DR. W.R. TROST

In any event, Gulf hasn't any underway, nor any projected at the present time?

MR. R.E. PAULS

There is the Aquitaine Plant and the Strachan Plant west of Red Deer here, and we are looking at participating with Aquitaine in a program that is underway right now in that area.

DR. W.R. TROST

If a person or a company, or a group of companies, or an association of companies were to consider the environmental effects that may arise from their plant, those environmental effects would be the things that are experienced in the surrounding area outside the plant and that were experienced by people inside the plant. Would your proposal be, if you were to consider constructing a program of research to look into the environmental effects that might arise from the operation of these plants, to actually enlist the co-operation of these two communities so that they could indicate the kinds of problems you should give attention to.

MR. R.E. PAULS

I would think possibly yes. I specifically state that, because we haven't formulated a program. I think that would probably be a preferable way of doing it.

DR. W.R. TROST

Would it be technically or organizationally difficult?

MR. R.E. PAULS

I don't think so.

DR. W.R. TROST

No particular hang-ups?

MR. R.E. PAULS

No.

Brief submitted by: S.C. Nelson

I have a 1972 truck and the grill on the front of the truck is rusted. We have to use plastic clothes lines. We had a galvanized clothes line and it is rusted. Canadian Superior was going to give us new clothes lines but they never did. They also said they would give us new sheets and blankets because of the rust on the clothes we were taking in. The paint on our house is peeling and cracking. Calgary Power put in one of those big high lines going up to the south Rocky Mountain House area and they said they sure didn't like to put it there because the insulators short the line out; the fall-out would come down on their lines and short the wires. I had a farm hand loader and I wanted to trade it with the machinery dealer, but he wouldn't take it because the hydraulic cylinders were pitted so badly he couldn't use it. Each cylinder is worth $180.00. My son-in-law, a chef at the University of Calgary in McEwan Hall, knew the fellow in the lab, and suggested scraping the rust off, and getting it analyzed. That is what we did. They analyzed it and when he went to pick it up, they wouldn't give it to him. They asked him "what do you want that rust for". He told them where his father-in-law lived, and they told him that they wouldn't give any results on that rust.

I am a Director of the Didsbury West Mutual Telephone Lines Company, and we just went underground but we are not hooked up yet. We had to replace two miles of telephone wire because I live beyond it. All the people in that area beside this Didsbury West telephone line couldn't get service because the telephone wire,where it was tied on to the insulator, was shorting out.

Oil companies have monitors on posts, little square boxes, and in the winter time you should be able to see tracks going to these boxes when they check them. However, there are never any tracks in the snow, so I don't know what the boxes are there for.

We have cows with foot trouble, and I have white muscle disease in my cattle. We lost a few cows this spring and then we started to vaccinate them with selenium. We gave them 1 cc, 2 cc's within twelve or twenty-four hours, and we lost no more calves this year. I took calves down to Dr. Sutmoller in Carstairs about four years ago and that was the first occasion I had with it. I had a big calf and took it down to him. It was a bright looking calf but it would stagger around. The wife and I fought with that for about three months, but the calf finally died. It just couldn't drag itself around to the grass to eat.

I used to work on the oil rigs for High Tower, and oil is a big business, there is no question about it, and the money is good. If I was still working for an oil company I don't suppose I would be up here talking about a person's health. I am trying to help these younger people that are going to be left. They put a well in south of us and we have a well on our own place. I'm surrounded by these sulphur wells and these stacks, which are about a hundred feet high. They brought this one in just south of our fences. I think it is about 1300 feet from our house. When they brought it in, it was in the winter time, and it was a terrible windy day. The wind was from the south and we live directly north of it, and a little bit to the west. They kept this cat running day and night at our gate to clear our road out, so we could go to a motel if something happened and the flame went out. Fortunately nothing happened and since then we have no trouble with our roads. Oil companies plough them out every year now, so we can get out if anything does happen. In November of 1968, they lit this fire south of us and it burned off a field of mine that was just seeded to hay. The next spring they came around to look at the damage and wanted to make a settlement. They brought land men and they offered me a price just to settle for the burning of this field. I didn't think it was a very reasonable price, so I refused it. I didn't know what to do exactly, so I went to the D.A. and I asked him what I should ask for the burning of my field. He figured it out, how many acres and that, and he gave me a price. I won't quote any prices or mention any names, but he gave me a price and it sounded awful high compared to what this oil land man offered me. I got another estimate, and it was a little bit higher than the D.A.'s offices **figures**. It sounded high so I asked for a lower figure than either of the estimates. Well, the land man said he would take it to Calgary, and let their lawyer figure it over, and see what he would come up with. He phoned me and he'd come up quite a few hundred dollars on his figure, but we were still quite a ways apart. He said that I could either take that or take nothing. I told them I'll take nothing if that's the way it is. There is another fellow who has been going to come up for several months but we still haven't gotten this settled. I'm just trying to point out how these big companies handle a fellow. They don't spray around the pipelines that they put through and then there are thistles. I figure weeds and thistles are pollution in this area.

I live right on the Little Red Deer River, south of Westward Ho five miles, and this oil company has a heater house right down the river. There was oil spilled all over the floor of the heater house. They brought in a pumping truck and washed the heater house out. They had designed the heater house so that there was a pipe leading into the Little Red Deer River, and that's where this water went that they used to wash the house out with. We get along well with the fellows that work for the oil company and one of the fellows suggested I phone the head office and tell them to quit washing these houses out and putting the stuff into the river. He gave me the name of the fellow to call. I phoned over and asked for this fellow, and he said he had designed the heater house and said "you don't like that" and I said "no" and he said "it will never happen again", and I don't believe it has.

There is another well, I'm surrounded by these oil wells, and late in the fall of last year the safety device blew out. We could smell this stink all afternoon, and we didn't know where it was coming from. Finally the valley got blue with this film. The problem is that most of the trouble happens on weekends when the supervisor is away. This was a Saturday afternoon. I believe it was the first snow we had last fall, and I could see this stuff coming out of the well and all over the ground. I phoned the plant and they said it was just a smell. I told them they had to do something about it; it was getting that we couldn't stand it. Apparently this device was shut off completely and had come on again. I went out the door after I had finished talking, and I heard a terrible hissing sound up north of us. I went back to the phone and told them that there was something wrong with the oil well north of us, and that was where it was coming from. He said that a man would be sent right over. I went out to the road, pointed it out to them and followed them up. A couple of hundred feet around the well site was oil. The fellow that went in made a dive and shut it off. I told him I didn't like the attitude they took over at the plant when I phoned over about trouble, and they had told me it was just a smell, and I had to learn to live with it. He said, "well, that's just the way it is, when a couple of families around here get killed, they will start to smarten up".

I have been going to a doctor for months; I had a sore throat, a hard time swallowing and shortness of wind. The doctor couldn't find out what the matter was and sent me to a specialist. He made arrangements with the ear, throat and eye specialist in Calgary. The specialist had to change my environment. I asked him "what did that mean" and he said the best thing to do was to get out of the sulphur smell. He said he was sending a full report to the doctor who sent me here, and I was to go down and discuss it with him. I went to the doctor and he read me the report, and it was written in the report that it was the sulphur smell. I'm getting so darned old and been there so long I don't want to change my environment; I'm happy there, we like it there. I thought I would change doctors to get more information on the source of my condition. I went to another doctor and he gave me tests on my throat and prescribed penicillin and a few other things that would cure it. I went back in seven days and I had the same throat trouble. He took more swabs and said the best thing to do was to go over to the hospital and get some more x-rays on my chest and throat. I did that, and now I've got an appointment with him next Tuesday to go and see if he has found out anything from these x-rays.

QUESTIONING BY THE AUTHORITY

MR. W.A. FLOOK

When you call up the plant to make a complaint or to report an incident, is there any specific person that you ask for at the plant, or do you just ask for anybody who answers the telephone.

MR. S.C. NELSON

I ask for the plant superintendent. I know him personally. Since they first put the pipeline in, I think about '63 or '64, when this well was put on. I get along good with him.

DR. W.R. TROST

Has there been any change in the last year or two as against earlier times?

MR. S.C. NELSON

In our area now there has. We used to have these flares from these batteries on each farm. Now they have one square and they've piped all these little flares to the big one about a mile and a quarter from us to the southwest. We do on occasion get a lot of smell from that, but it depends on which way the wind is blowing. I think the oil company has cleaned the smell up an awful lot. They might be taking the smell out and it's still there, and we can't smell it; or maybe we're losing our smell, but they are doing something.

Mr. H.W. Becker summarized
the Canadian Petroleum Association
brief presented in Calgary.

Brief submitted by: Mrs. T.E. Lynn

We have lived on our farm at Nevis for 48 years. I have raised my family there, and never had any trouble till this last few years. Our youngest son has taken over the farm and he has this terrible cough. His symptoms are just like Mr. Nelson's. For a number of years, I have had a terrible cough. I went to the doctors and had x-rays done but they couldn't find out what was wrong. I have been sent to Edmonton, Red Deer, and Stettler. I coughed all last summer but when I went away to Arizona for the winter, in one week my cough left me. I came back this spring and the cough started up again. When I was in B.C. for a while, again the cough left me.

My son has these same symptoms: sore throat and he is always tired. He is only 43 and he would like to give up the farm. We would like to sell it, and when we had a man come to look at it, he was very impressed. We have a beautiful modern city home on it, and I have my old home on it. He was going to buy it, but our good neighbours, when he went to ask them about the place, told him he would not want to be that near the plant. They told him he would have trouble with his cattle. We have had fat cattle drop dead not knowing what it was. We didn't figure we could afford to get a veterinarian to come and tell us what was wrong, they were dead, so just what they died from we don't know. The symptoms were like Dr. Sutmoller said: some of the cattle were breathing so hard the first thing we knew, they were dead. Some of them were almost ready to go to the market.

Last year, I woke up about 2:30 one night, and I felt I couldn't breathe. I got kind of hysterical and phoned my son and told him it smelt like gas. He said to phone the plant. The Nevis plant is within a half a mile to three quarters of a mile from us. I phoned them, and they did come up to my place, I can't remember exactly when, and talked to me about it. They didn't figure it was the plant; they figured it was the well south that may have gone out. They asked a man to come from Erskine to go and examine this well and he did, but they never reported to me. The next morning, I phoned to Erskine and I got his wife. She was quite perturbed that I had gotten her man out of bed at 2:30 in the morning to come and see if this well was out. I just couldn't breathe, that's all there was to it.

What my main worry is that my son keeps coming to me every day and he'll say "Mother - I hurt so, my lungs hurt". He has been to doctors and had x-rays, but they don't seem to be able to find what is wrong. They don't know what it is. He has asked them if it could be the pollution. If it could be something from this oil well, because we have been told that there was poisoned gas at one time. I do believe I have found that it is much better this summer and fall, than it was last year - I can verify this. I think they are trying to control it. My son still tells me he hurts and that he is tired and feels that he wants to leave the farm, just walk out and leave it. This has been his whole life: to take over the old home, the old farm, and to work it. He told me to come here today and ask who I can see. He has been to doctors; they can't tell him, but he said, see if these people that are here today can tell me what I can do, where I can go to get help. Should he leave the farm? What should he do? He is bewildered, gentlemen, and so am I. I am very perturbed about it. He is a young man, and his wife is complaining now of her lungs. Sometimes when the evening meal is ready one of the children will say he is sick to his stomach. This has not happened before. We are asking, if anyone does know what it is we would sure like to know.

I had several clotheslines. I had one for years and years, an old galvanized wire, and then my husband put another two or three new ones on. At last, I have had to have my son put up a plastic line so that it would not rust. Everything we have is rusted. If our machinery has a little bit of paint off, it is rusted. I left my silverware out while I went away a few winters ago, and when I came home it was black. I have had to polish it and clean it and wrap it in black paper and put it in plastic bags. This way I can keep it from tarnishing. Every bit of silverware I have, dishes or anything that has any silver, is tarnished. I wonder if it does this to your things like this, what must it do to your lungs? It must do something, because I myself had it in my lungs.

They mentioned the oil rig they had trouble with. I think they were trying to do some repair on it and the wind blew it over. It was said that all precautions were taken. There are quite a number of us who live on the line, a mile line. Everybody was evacuated but four families: two south of us, ourselves and my son. They were told to get out but we never knew anything about it till later when one lady phoned and asked me if I got out today, and I said "no, what was the matter?". She told me and I said that I had noticed that along the river we could see what appeared to be a white cloud. I was told later that had my son been working on our river flat he might not have been here today because it was poison gas.

I do hope that we can find some solution. I don't know what it is - whether my son should leave the farm or if he can find something to improve his health.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

You have been near the plant for a good long time?

MRS. T.E. LYNN

We have lived there 48 years, long before the plant was there.

DR. S.B. SMITH

And how accurately do you think you can date the problems that you see?

MRS. T.E. LYNN

I haven't kept a record, but it's been a number of years ago that I had this terrible congestion and cough. I could go to my doctor in Stettler. I had to keep going to him for this trouble.

DR. S.B. SMITH

Could you forward it to us because I think it could be of interest.

MRS. T.E. LYNN

Yes I could. Not only that, I have been to Red Deer and I have been to Edmonton throat specialists, and they don't seem to find anything. They have x-rayed me; and my son the same, he's been to Calgary, Stettler, Red Deer, but they just don't know.

MR. W.A. FLOOK

You and Mr. Nelson, more than anybody else who have spoken to us at these hearings, seem to bring out the oil well or the gas well as a source in addition to the plant. Do you feel that the source of your trouble is more centered around the well than the plant; or the other way around?

MRS. T.E. LYNN

I don't know. We are surrounded by these wells, and we have two plants not very far from us, one is between half a mile and three quarters and the other maybe a mile and a half or two. When that plant first went in there was a man living within half a mile of there and he complained about the smell and everything. It wasn't long before one of his children died of pneumonia. He blamed it on to that; he wouldn't take no for an answer. So they went to him, they bid, kept bothering him, and then they bought him out.

MR. W.A. FLOOK

The wells that are in your vicinity, are they oil wells or gas wells?

MRS. T.E. LYNN

There's both.

MR. W.A. FLOOK

You couldn't say approximately whether your difficulties started at the time the wells came in, or the time the plant came in.

MRS. T.E. LYNN

I think that the plant mostly. There was a terrible lot of smell. I had relatives come from Santiago in California, and in the middle of the night she got up and she came to my room and said "Have you left your stove on?". I said "I don't think so", and I got up, and you could hardly stand the smell of it. And I said "Well, that's coming from the plant". We just thought we had to put up with it, that's all. We didn't think there was anything we could do about it.

MR. W.A. FLOOK

When there is an incident involving the plant, and you call them up, is there always somebody there who can generally take action?

MRS. T.E. LYNN

Yes. They have always been very kind. They have come to my house in the middle of the night. I do appreciate, in fact, this one night that I talked to them when it was bothering my breathing. After they talked to me, they phoned the man in Erskine, and they said he would come right out. He came out, but he never reported it to me.

MR. W.A. FLOOK

When that happens, is there a significant amount of time between your reporting it and them coming out to do something?

MRS. T.E. LYNN

No,they have been very good. They immediately look after it when I speak to them. I have no complaint that way.

DR. W.R. TROST

You did say that the situation is improving this summer and fall.

MRS. T.E. LYNN

I think it is, only that my son is complaining of this lung trouble. Mr. Nelson is always with this very bad throat. It's his lungs that are troubling me, because I am beginning to worry if it is emphysema. He is a young man and he has a wife and two children.

DR. W.R. TROST

Do you think that the conditions are satisfactory now, or do you think that the standards should still be strengthened?

MRS. T.E. LYNN

There isn't the smell that there was, but has the harm been done or is there still a certain amount in the air that is aggravating it? This is what I would like to know. How can they prove this, how can they find out? I would like to get to the bottom of it.

MR. S.C. NELSON

The operator that has a lot to do with the stacks at this Harmattan Nelson Plant told me that that stack is only 250 feet high. And the heat, it's not near hot enough, he said that if it was 500 feet high, and increase the heat or it, we would have far less pollution or fall-out around our places -- is that correct could you say?

DR. W.R. TROST

I could find out for you. We could take your question from the record. Is there any further discussion?

DR. H. SUTMOLLER

Mr. Chairman, may I raise another point? There is a great deal of confusion where your Authority starts and where the Energy Resources Conservation Board ends. I know there have been farmers who have come in to me and said I want to register a complaint. Where do I go? I believe in the past it has been the policy to consult the Resource Conservation Board. These people have been, in my opinion, notorious in being partial to doing investigations, and very lackadaisical in their investigations in trying to find out whether it's going at all. It would be my hope with the establishment of the Environment Conservation Authority that things will start to shape up a little bit, and that there will be a few more teeth put into the laws and standards, so that we really feel we have a place to go to get some impartial investigations done. Am I correct to say that in the future if there are problems concerning the oil and gas industry which we feel might be affecting animal life, that we will be consulting your Authority rather than the Energy Conservation Board?

DR. W.R. TROST

I think if there are matters or complaints about environmental effects of specific nature, you should go to the Department of the Environment, the Pollution Control Branch, If they are matters that relate to the technology of the plant, then the Energy Resources Conservation Board would be the right place.

DR. H. SUTMOLLER

How can we differentiate between those two fields? I mean, this is for the average person, he is not capable of knowing who to call in a case like that.

DR. W.R. TROST

If it's outside the boundary of the plant itself, then it's an environmental effect, and you can properly and appropriately contact the Department of the Environment through the Pollution Control agency or some of its branches.

PUBLIC HEARINGS
WHITECOURT

OCTOBER, 1972

ENVIRONMENT CONSERVATION
AUTHORITY
9912 - 107 Street
Edmonton, Alberta
T5K 1G5

INTRODUCTION OF A SUBMISSION TO THE ENVIRONMENTAL CONSERVATION AUTHORITY

BY

WHITECOURT ENVIRONMENTAL STUDY GROUP

Presented by: E. Baranuk

Discussion

The Whitecourt Environmental Study Group was formed in March 1972 by sour gas plant operators who were concerned about the short and long term environmental effects that might be caused by their concentration in this area.

There are twelve sour gas processing plants in this 120 mile long by 40 mile wide section of the Whitecourt forest. One third of industries' SO_2 emission occurs in this area. A co-operative Group such as this one can obtain more useful information than would be possible by each company making independent surveys.

Objectives of the Group

1. Determine the effect of the plants on the environment.
2. Determine the effect of adjacent plants on each other.
3. Determine the long term effects on the environment.
4. Advise results of the Study.

Studies Would Include but not be Limited to:

1. Plume dispersion studies at each plant under various synoptic or weather conditions.
2. Climatology study.
3. Infra Red aerial and temperature line scan surveys.
4. Ground vegetation studies throughout area.
5. Soil samples and studies.

6. Water samples and studies from streams and lakes.
7. Review and supplement as necessary all available data on vegetation, animals, birds and insects in the area, and the effects caused by the industry.

Length of Study

1. Study would be an accumulation study of data over a three to five year period.

The Whitecourt Environmental Study Group retained the services of Dr. Bob Holmes to achieve their objectives. Dr. Holmes is an acknowledged leader in the technology of environmental monitoring. His company has in addition some of the most modern, sophisticated equipment in the country to perform this work. Born in Raymond, Alberta, he holds degrees from Brigham Young, Rutgers and Michigan universities. He has studied biological sciences, geography, plant ecology, soil physics, meteorology and instrumentation physics. Dr. Holmes has spent 15 years as an environmental research specialist with the government of Canada and for six years has been an independent consultant to government and industry. Dr. Holmes is well known in Canadian environmental circles for his application of remote sensing techniques in the analysis of ecological systems.

On September 22nd, Dr. Holmes made his first interim report to the Whitecourt Study Group and we felt that his comments should be presented to the Authority.

Summary Comments:

1. There are mild local effects on the environment as a result of these large sour gas processing plants.
2. Effects from SO_2 emissions appear to be transitory and are not as severe on the environment as natural causes such as invasion from insects, disease, forest fires, wild animals, floods, drought etc.
3. We have seen no permanent damage from SO_2 in the area and one plant has been in operation for over 10 years.
4. We are still learning and intend to continue in this type of environmental monitoring, expanding our work as necessary to include any new study techniques as they become available.
5. We would welcome comment from the Government, the public and the community on our efforts.

E. Mc[illegible] P. Eng.
Chairman - Whitecourt Environmental Study Group

BRIEF

SUBMITTED TO THE ENVIRONMENTAL CONSERVATION AUTHORITY

ON BEHALF OF THE

WHITECOURT ENVIRONMENTAL STUDY GROUP

- AMOCO CANADA
- PETROFINA CANADA
- CHEVRON STANDARD
- CANADA-CITIES SERVICE
- HUDSON'S BAY OIL & GAS
- PACIFIC PETROLEUMS
- SHELL CANADA
- TEXAS GULF INC.

CHAIRMAN: EDWARD BARANIUK, AMOCO CANADA

by

ERA INSTRUMENTS LTD.

DISCUSSION OF PRELIMINARY RESULTS

Presented by: Dr. R. Holmes

ERA • ENVIRONMENT RESOURCE AIRBORNE INSTRUMENTS

PREFACE

The Whitecourt Environmental Study Group was formed in March of 1972 by sour gas plant operators in the Whitecourt District who wanted to obtain more accurate information about the short and long term effects of natural gas production operations on the environment. Since the Study Group was formed only recently the present report is preliminary but draws on environmental data recorded in the past as well as from recent studies. The five-year study plan of the Group includes aerial infra-red photographic surveys of plant life, climate analysis, aerial plume dispersion surveys and soil sampling. Also to be continued is collection and analysis of data on vegetation, animals, birds, insects and water.

The environmental study group is composed of eight companies in the Whitecourt forest area. They are Amoco Canada, Petrofina Canada, Chevron Standard, Canada-Cities Service, Hudson's Bay Oil & Gas, Pacific Petroleums, Shell Canada, and Texas Gulf Inc.

Group chairman is Edward Baraniuk, P.Eng., of Amoco Canada who emphasized that through the objectives and activities of the study, a cooperative group could obtain more useful information than would be possible if each company made independent surveys. As a result of this continuing study, the participating companies will be able to identify potential environmental problems arising from their plant operations, and undertake remedial action well in advance of the occurrence of any permanent damage in the study area.

Comments are invited from government and the public.

"The figures referred to in this submission are listed below. Those figures indicated by an asterisk are not reprinted in these proceedings but are available for viewing at the Information Center, Environment Conservation Authority, 9912-107 St., Edmonton, Alta.

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PRELIMINARY RESULTS
of
ENVIRONMENTAL RESEARCH IN THE WHITECOURT AREA
WHITECOURT, ALBERTA

R.M. HOLMES

Mr. Chairman, members of the Environmental Conservation Authority, Ladies and Gentlemen: Mr. Baraniuk announced that members of the Petroleum Industry have commissioned ERA Instruments Ltd. to conduct a detailed study of the environment of an area that surrounds their sulphur extraction gas plants in the Whitecourt area of Alberta. I have been asked to give a report of the preliminary findings of this study, which began during early summer.

In order for us to understand some of the details of our work to date, it is necessary that I discuss with you for a few moments some familiar concepts concerning the nature of the environment.

The term "environment" is a word that simply means, the "ambient conditions" that exist at a particular location. Natural laws are universal and those that are operative at any one place are complex. Each space or area has its own unique characteristics that are the result of natural laws that govern the behavior of all matter in that space. For example, the laws of natural selection in any particular region produced the biological forms that exist there. Further, the manner in which natural laws have operated has produced the normal environments. These phenomena are highly variable; some vary from day to day and season to season. In fact, nature has never duplicated a given day; no single winter has ever been exactly like any other; no spring season has been the same as any previous spring. While natural law per se is absolute and irrevocable, the visible manifestations of natural laws vary with geographical location. In fact, this type of variability is the very essence of Nature.

May we consider what this means in terms of the environment in the Whitecourt area. Consider the temperature extremes to which the vegetation is subjected through a cycle of seasons. Logically, if the plants were not able to withstand this, they could not survive. The vegetation that grows and flourishes here, does so by virtue of the fact that it can withstand and indeed depends on the extremes and variations in temperature, moisture, sunlight, wind, etc. The communities of poplar, spruce, pine, juniper, the animals, insects, etc.,are all indigenous to this region because they can either survive or depend on the extremes and variability in the environment to complete their life cycles. All these processes and phenomena are the result of the conformance of all living and inanimate forms to natural law.

This concept applies to all nature regardless of position on the surface of the earth. It is important to understand that environmental extremes and variability do not produce delicate balances in nature, but "zones" or "domains" of stability. In some regions environmental variability is small,and so the domain of stability is restricted and may give the impression of the ecology being in balance. In actual fact the ecology is never in balance and is in a state of continual change, but always within its particular domain.

To this point we have dealt only with Nature. Consider for a moment man's influence on zones of stability in the environment. He may strip off the natural trees to plant crops or to make wood products; he can make deep incisions across the forests for a road or pipe-line right-of-way, all of which seriously intrude into the "normal" ecology and create yet another factor to be considered in delineating the zone of environmental stability. One then determines whether this intrusion can be safely absorbed within the natural domain, or whether it will in fact create new zonal boundaries that may be unacceptable. Please examine Figure 1.

This highly idealized diagram suggests the above concept. It is not a rigorous illustration and is designed only to indicate the essentials of the concept of environmental stability. Note that each axis has lower and upper ranges, which suggest that

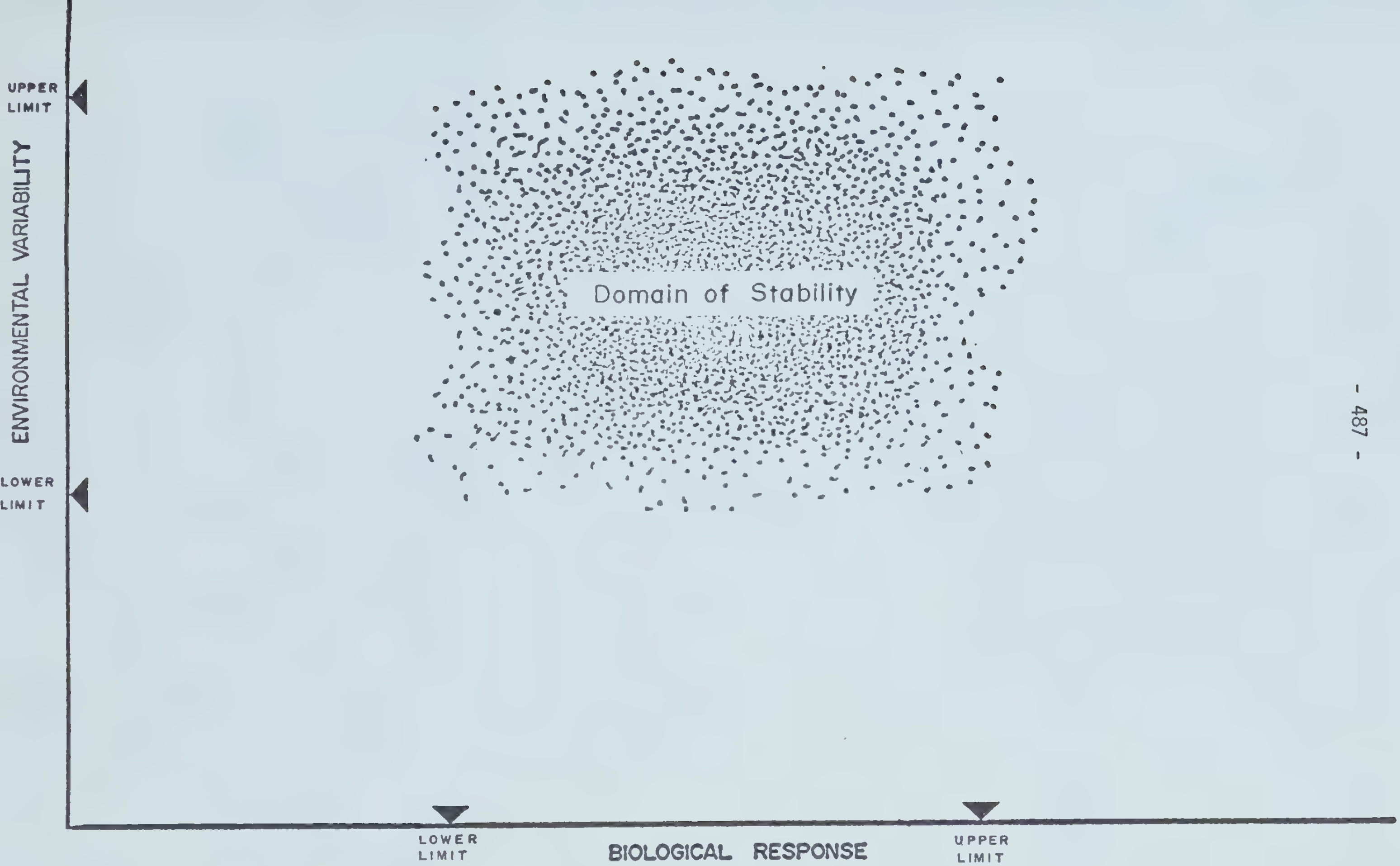

FIGURE I.

Qualitative Representation of Biological Response to Environmental Variability biological response to environmental variability is not sharply delineated. The diagram suggests that a given amount of environmental variability has a certain biological response. The net result in time is that a domain of stability is created. This suggests that as long as the variability of the environment is within the limits that caused the various biological responses, the domain will remain relatively constant and the various biological entities will display a degree of resilience by "moving around" (responding) within it. The various responses may be negative or positive depending on the entity affected. Note also that the illustration suggests that the area of the most numerous biological response is not near the edges of the domain. It is at the edges that extreme environmental conditions exist and cause the greatest uncertainty in survival of any particular entity. We can carry the argument further to include the effects of man on the environment. If the environmental variability is not altered to the point of exceeding the limits that originally created the response limits of the biology, the domain will remain essentially unchanged and will absorb man's input.

Figure 2 illustrates some of the complexities of environmental variability where radiation is concerned. Notice that this diagram deals with radiation reactions during a typical day and night time situation. During the day, the solar energy input dominates the picture. Some of the energy is reflected or absorbed by the atmosphere. That which reaches the surface of

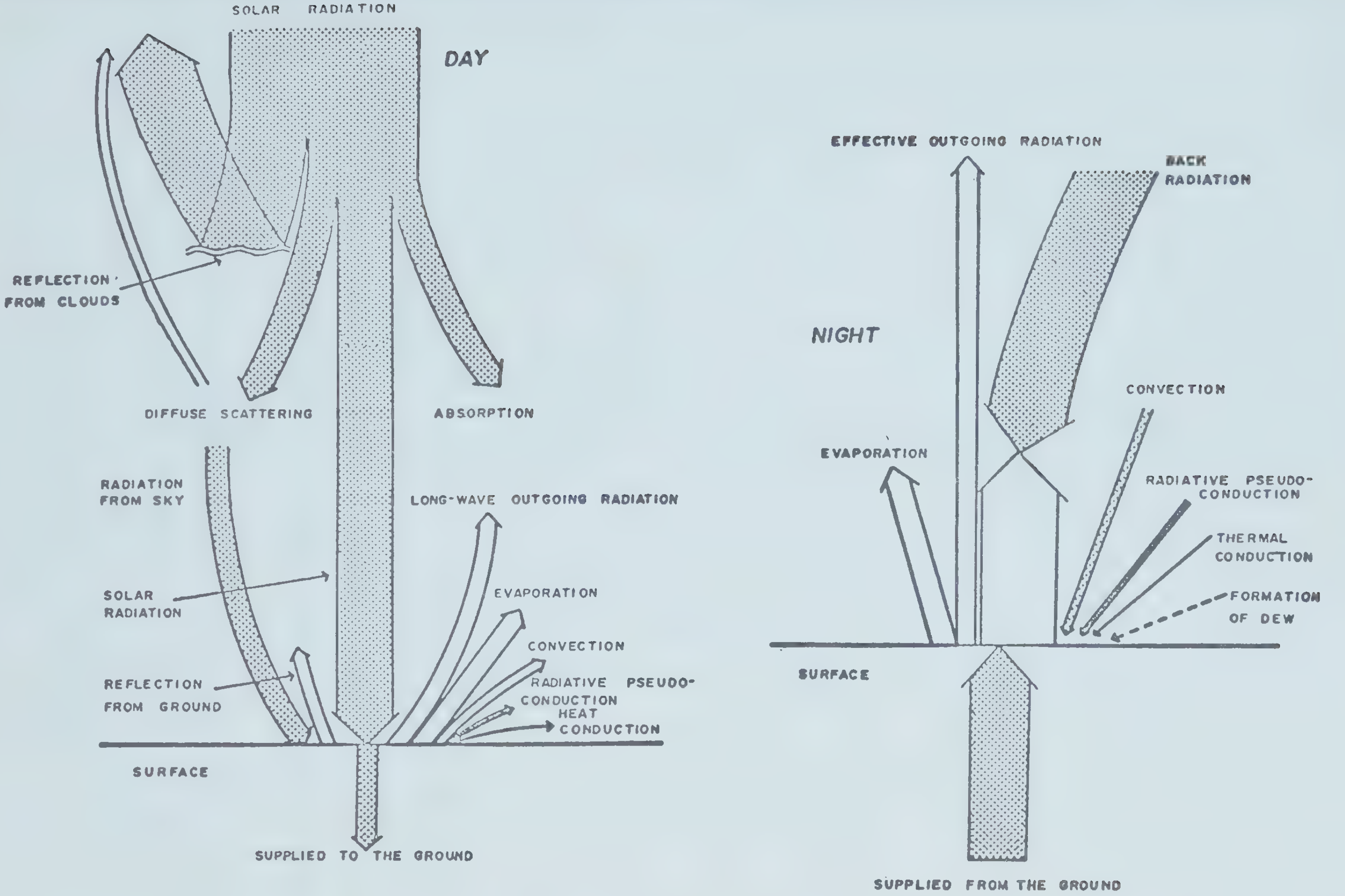

FIGURE 2. NATURAL RADIATIVE PROCESSES AT AND NEAR THE EARTH'S SURFACE.

the earth is apportioned into many segments of the environment depending on the nature of the surface. The apportioning of this energy at the surface has more to do with determining the nature of the surface and life on it than all other environmental factors combined. At night, back radiation from the sky and surface is the dominant reaction. Surface characteristics have enormous input into the magnitude of each of the radiative reactions at night which determine rate of cooling, dew and fog formation, vegetation frost damage, rate of drying, etc.

Figure 3 presents an illustration of horizontal variability in a transect of surface in a semi-arid area of agriculture. Note how warm and cool parcels of air are generated by underlying surfaces and move downwind affecting other underlying surfaces. Notice that the surface imparts its characteristics to the atmosphere and visa versa. Consider Figure 4 which is the plan view of the vertical transect in Figure 3. Parcels of cooled and warmed air pass over the various surfaces some of which are hot dry land, cool irrigated land, lake, etc. Consider the effect of a change in wind direction. Such variability as occurs from season to season produces particular biological responses. The upper and lower limits of causes and effects produce the boundaries of the domain peculiar to this region.

*Figure 5 is a view of agricultural land in the Rocky Mountain foothills. Zones of stability are evident from that in the agricultural land, to the wooded foothills to the steeper slopes,

*See "List of Figures" as outlined in the beginning of this submission.

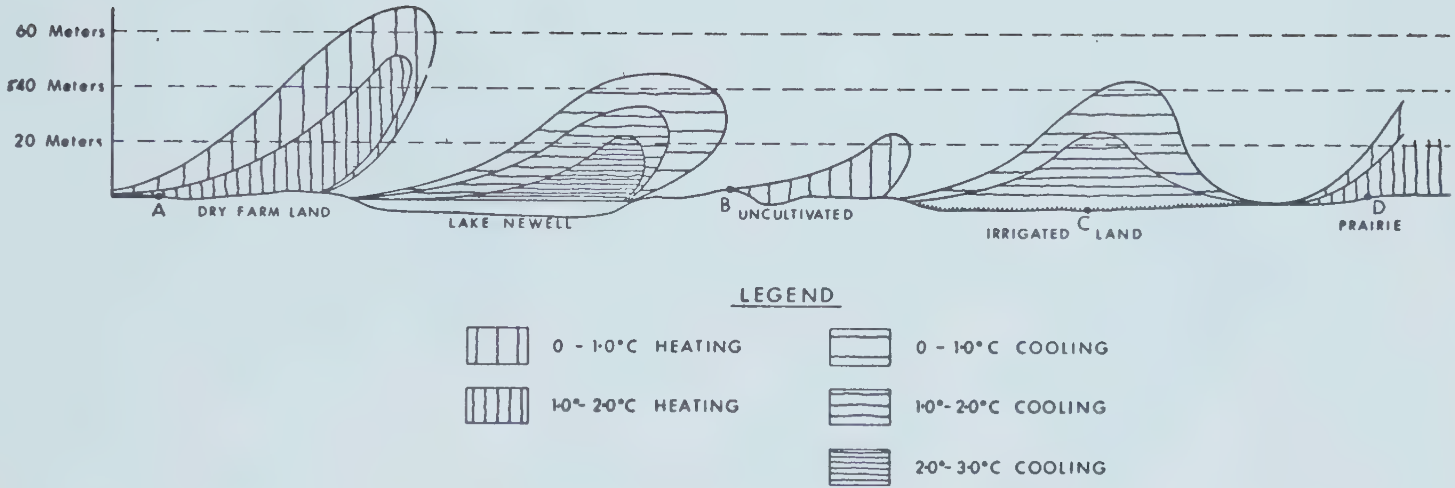

FIGURE 3. Temperature profile of air temperature over ground track A, B, C, D, over area near Brooks, Alberta, on August 6, 1968.

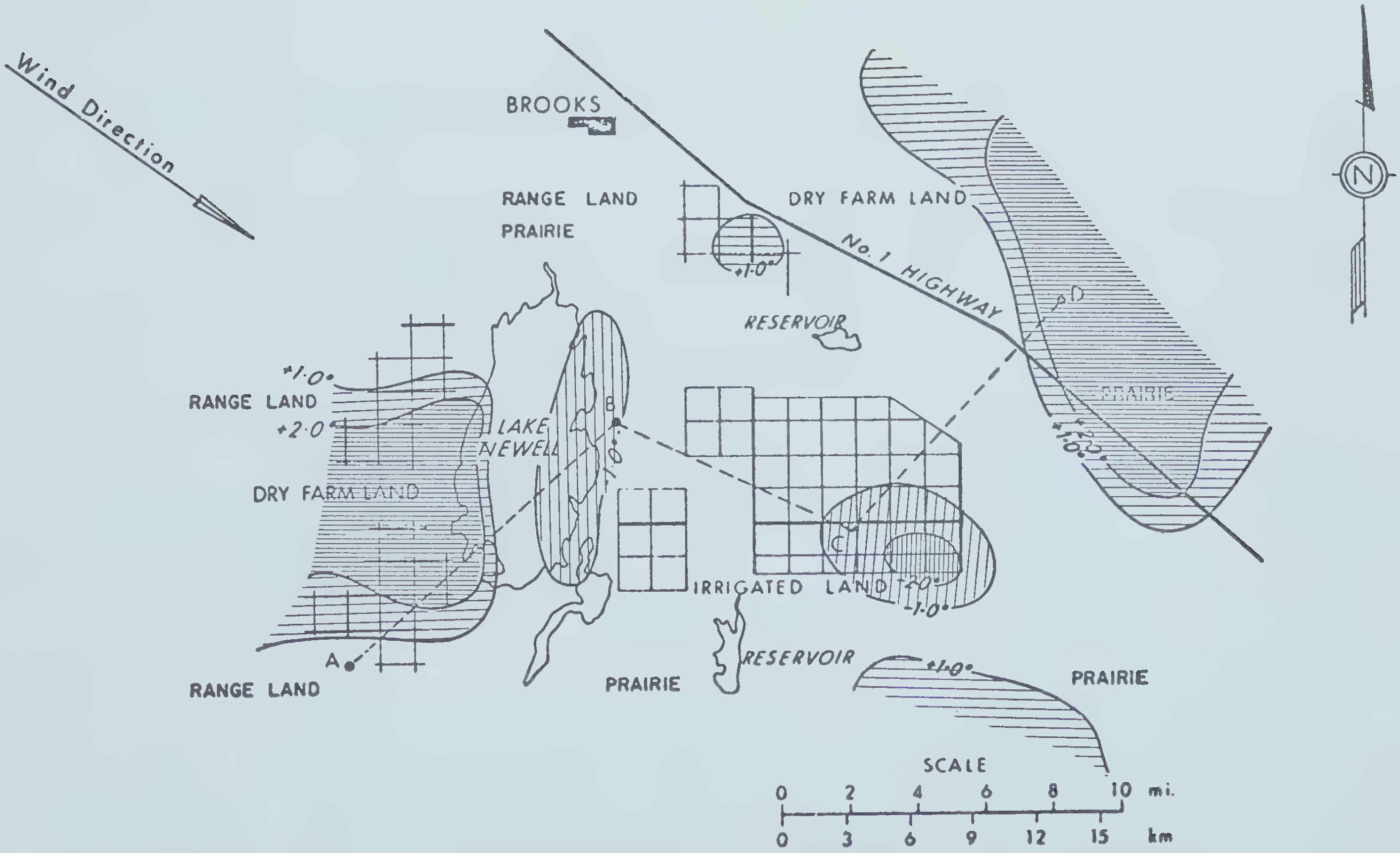

FIGURE 4. Isotherms of average air temperature difference (°C) at 40m. above surface between positions indicated and ambient prairie air 8 km. upwind near Brooks, Alberta, on August 6, 1968

and even into the atmosphere. Each domain carries its particular set of conditions that have resulted from the environmental variability and biological responses to that variability. It is interesting to note at this point that agriculture in this domain is artificial. It was imposed by man onto another previous domain. If the agricultural entities were not renewed and maintained each year by man's efforts, the area would slowly return to its previous biological make-up and the original domain would return.

Figure 6 is an area of muskeg in the Whitecourt region. It is there because of a particular set of atmospheric and ground water conditions to produce only a moderately stable domain as we normally reckon time. Such a situation however, is very sensitive to surface and near-surface water changes and is undergoing very slow changes. Hence the limits of this particular domain of stability are regulated by the hydrology. It is interesting to contemplate the long-term effects of rights-of-way and seismic lines on such areas where horizontal movement of ground water is so important.

Figure 7 is a climax stand of spruce and pine. The zone of stability of such an area is fairly broad since this vegetation is able to endure very large amplitudes of environmental change.

Salix gauca grows in much of the foothills area of southern Alberta. The normal habit of the plant is for the older branches to die back from the crown while new growth begins from the crown. However, the older and dead branches persist within the communities, giving a very "straggled" and unattractive appearance. The hillside in Figure 8 supports growth of this willow, where the intense die-back gives a brown color to the communities. A close-up view is in Figure 9. This plant is very hardy and can withstand great climatological extremes and hence imparts stability to a broad environmental domain.

Insects derive their sustenance from vegetation and in many areas provide very visible biological response to environmental change. Note in Figure 10 where a community of *Populus tremuloides* has been attacked by a leaf curling insect that can completely defoliate an entire hillside of Populus. The population of such insects rises and falls (as do most biological responses) in harmony with the extremes and variations in the environment. At some periods the insect is difficult to find, and at other periods it is so numerous as to devastate large acreages of trees. Figure 11 is a close-up view of the action of *Phyllocnistis populiella*, a leaf curler insect. Figure 12 is a view of a leaf miner insect that is nearly always present in populus, but not as devastating in its effect as the *Phyllocnistis*. Notice by contrast, the populus in Figure 13 which are unaffected by insect stress. It is obvious that our concepts of environmental variability and biological response must include insects, since they may have a marked and somewhat restrictive effect on the domain of stability of the ecological system. If the trees in Figure 10 for example are subjected to such an attack for three successive years, the community would not likely survive.

For the sake of completeness, may we include the effects of animals into our "domain" concept. Notice in Figure 14 how wild game has affected a stand of Populus. Nearly all of the mature trees in a large community had been killed due to girdling by beavers.

For further comparison, may we examine another of man's inputs into the ecology as shown in Figure 15. This shelter belt row of Populus and ash is showing mild stress symptoms of SO_2. Although this is the first time this row of trees has been examined, it is likely that it has been subjected to periodic SO_2 doses for many years. Yet each year the vegetation has put out new buds and leaves. Obviously, the SO_2 input has been of such a nature as to not encroach on the stability of this domain, far less at least than the insect intrusion of Figure 10. Figure 16 is a young balsam poplar tree that has been affected by leaf miner insects and sulphur dust. The leaves show the effects of these stresses, and yet each year this young tree sends out new growth. Notice Figure 17 which is a view of wolf willow under mild SO_2 stress. Later in the season, the visible stress symptoms in this large community had substantially reduced. The stress had been removed and the vegetation began to recover. This points to the resilient nature of the biology in many domains.

We have moved into the specific area of SO_2 stress, and I should like to present a few illustrations of affected vegetation found in Alberta. I should like to point out, however, that great caution must be exercised in making such diagnoses. Many stresses can visually affect a plant in such a way as to mimic others. Some nutrient deficiencies can be easily mistaken for industrial effluent stresses. Much research has been carried out in greenhouses where stresses were noted under controlled conditions. However, a plant that is grown in the greenhouse and subjected to industrial effluent such as SO_2, may display much different visual symptoms when subjected to the same stress in field conditions. Causes of plant stress in the field are often very difficult to interpret and diagnostic skill is acquired only after long familiarity with many environmental situations.

While the Populus tremuloides in Figure 18 were exposed to SO_2 in field conditions, the leaves show classical SO_2 toxic stress symptoms as might be encountered in the greenhouse. The stress is called toxic because the dosage has resulted in the death of the affected tissue. Notice however, that only about 30-40% of the leaf area is affected. The balance of the leaf area is still green and continues to perform its function, albeit at a possible somewhat reduced level. Figure 19 is another but less classical manifestation of SO_2 stress in Populus tremuloides in the field. Figure 20 is a view of a similar tree eight weeks after exposure to high levels of SO_2. While the tree has been reduced in vigor, the buds were not damaged and the tree could be expected to revive the following season. Notice that the SO_2-affected leaves did not replace the damaged tissue. Figure 21 is a view of buckbrush that has abundant regrowth following exposure to high SO_2 levels that were sufficient to completely kill the early growth. Figure 22 is a similarly affected ground juniper that is showing regrowth. Figure 23 however, is trembling poplar that has undergone SO_2 stressing but at levels insufficient to cause death of the leaf tissue or the buds. Although much reduced in vigor, the tissues continue to perform their function. As a point of interest, notice Figure 24 which presents a section of Populus tremuloides suffering from a nutritional disorder, next to a healthy branch tip. It can be seen that these stress symptoms are much different from those of SO_2.

Nutritional deficiencies are common in nature and comprise part of the biological response to external stress which in turn contributes to the characteristics of the particular domain within which the vegetation resides. Similarly, insect and animal stresses are part of the ecosystem. All of these contribute to the nature of the particular domain of stability, and establish the extremities of the domain. If SO_2 is injected into an SO_2-free environment, it will be incorporated within the indigenous biological systems, and will create its particular response pattern.

High levels of SO_2 may impart a new character to a domain and significantly alter the boundaries. Entities can be expected to show differential response to SO_2, with strong response to some and negligible effect on others (e.g. lichens are very sensitive to SO_2 but the conifers on which they can grow are relatively resistant). Many such interactions may be found and could cause unacceptable changes in the boundaries of the stable domain. However, if the dosage of SO_2 is low, no effects on the existing limits will be noted.

At this point, Mr. Chairman, I should like to point out some of the environmental effects that we have measured in the Whitecourt region, that are relatable to the gas plant industry. Figure 25 is a map indicating the location of the gas plants in the Whitecourt area. Approximately 1/3 of the sulphur of Alberta is recovered in this area. The direction of the principal prevailing wind is from the north-west which is in the general direction of the long axis of the study area.

I do not propose to present all of our data to date. I should like to refer to only a few of the gas plant sites and some of the observations related to those areas.

Figure 26 is a view of Cities Service Paddle River Plant near Mayerthorpe. It is located on an elevated area of terrain surrounded by agriculture. Many wooded lots and shelter belts remain however, and this permanent vegetation was studied in

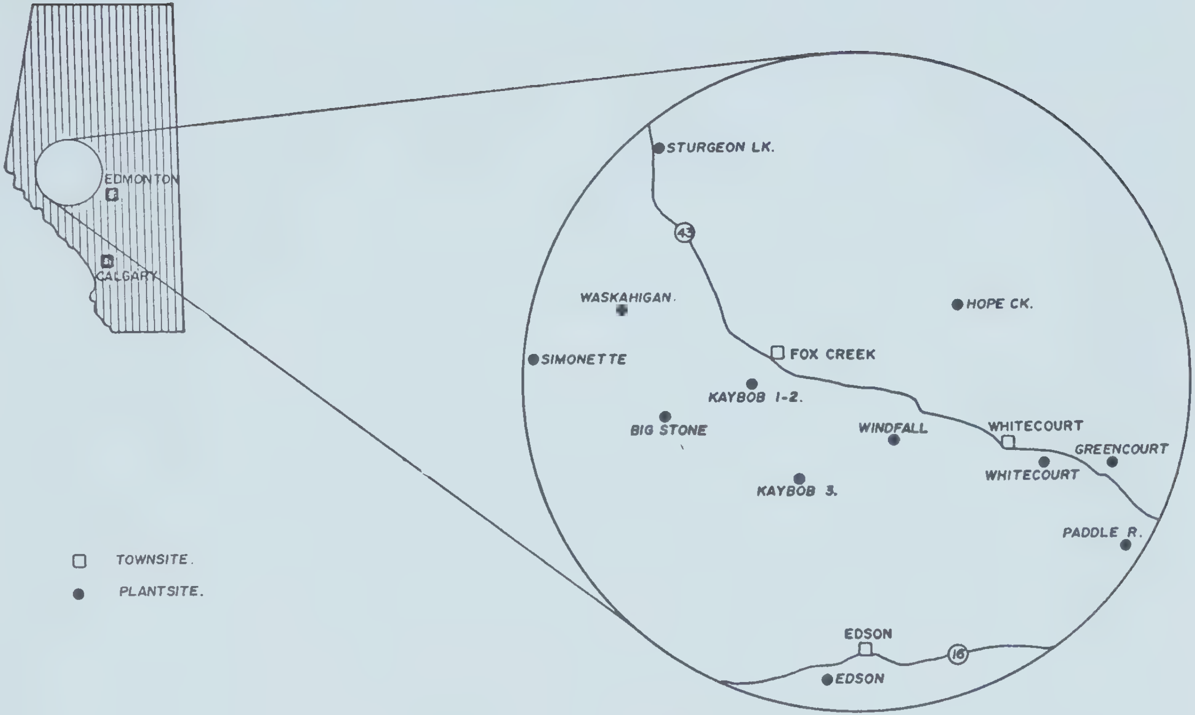

FIGURE 25 LOCATION of WHITECOURT ENVIRONMENTAL STUDY GROUP AREA, WEST CENTRAL ALBERTA.

particular. Figure 27 shows a spruce tree (and a portion of another) that is affected by a spruce fungus that has defoliated the upper part of the large tree. The tree just visible in the lower right is severely affected. No SO_2 symptoms were noted. Figure 28 is a shelter belt row of poplar that showed mild SO_2 stress at the time of the photograph. The large wood lot at right centre was similarly affected. A large lot of trees is situated to the west and southwest of the gas plant. The population is mainly coniferous, as shown in Figure 29. The spruce were variously affected by fungus, the pine was normal and the deciduous trees were unaffected. In general, the principle areas of vegetation stress were observed to be one to two miles to the south and southeast of the gas plant in stands of deciduous trees. Stress symptoms were noted up to three miles from the incinerator stack. Toxic SO_2 stress symptoms were not observed at any location surrounding the Paddle River gas plant.

At this point, it is interesting to note that an agricultural domain has replaced the original mixed forest that covered the area. While the change is normally considered to be benign, it is nevertheless a strong contrast to the domain that existed previously.

The Whitecourt gas plant of Pacific Petroleums Ltd. is shown partly concealed by forest in Figure 30. The forest is mainly deciduous with some spruce and pine. Notice the area of pine burn in the shallow depression and slope immediately beyond the gas plant. This phenomena will be referred to later. Figure 31 is a view of the perimeter of the gas plant and shows the effect of the construction on the nearby vegetation. The symptoms noted suggest mostly root damage due to the construction activity. Other stresses exist, but were not relatable to SO_2 and are likely due to the proximity of the flare stack and other equipment. In Figure 32 is presented a closer view of the pine growth showing pronounced needle burn. Figure 33 was taken within the pine stand and shows the same pronounced effects. A close view of a branch of pine is shown in Figure 34. The needles that are severely affected are from the previous season. These symptoms partly suggest the effect of ozone (possible from a subsidence inversion) or a "chinook burn". It is more likely the latter, since chinooks are common and can cause very rapid fluctuation in tissue temperature. High temperatures and winds stimulate recovery of the needles from winter dormancy. When the cold temperature returns following the chinook, the needles are not able to survive.

Figure 35 is a view of the Windfall gas plant (Amoco-Texas Gulf) which is located on a raised portion of terrain and is surrounded by mixed forest of Populus tremuloides, pine, spruce, and muskeg. The winds were light and variable from the southwest and due to the strong surface heating, a pronounced looping plume developed from the flare stack. Under such conditions, plume constituents could come in contact with the surface at almost any point along the plume track. Since looping plumes are common during the vegetated season, and since plant stress could therefore develop from SO_2 at any point surrounding the gas plant, the entire environments were examined.

Figure 36 is a young balsam poplar showing a mild chronic SO_2 dosage. This diagnosis was made due to the general chlorotic condition and the characteristic discoloration in the leaf intercostal area near the margins. This tree was examined about three weeks later, and the symptoms had disappeared. This points to the transitory nature of chronic SO_2 stress. Figure 37 is a similarly affected lodgepole pine. This branch is showing affected needles from this season as well as the previous season's growth. The SO_2 symptoms are typical of chronic doses. To the northwest of the plant is an area of fungus-infected spruce, similar in proximity to that observed at the Paddle River gas plant. The trees are strongly affected over a wide area which is most pronounced near the gas plant, but becomes more spotty toward and across the Athabasca River to the northwest. Notice the affected parts of the trees in Figure 38. This view is from the ground looking upward into the tree. The present year's growth of needles is infected.

Figure 39 shows a low ridge of mixed forest on the southeast of the gas plant. In the foreground is an area of very young conifers. The deciduous (Populus tremuloides) trees displayed mild chronic SO_2 symptoms over much of the crest of the ridge, but the conifers were unaffected. Nearer the sulphur storage blocks is an area of muskeg with short spruce and with pine nearer the roadway shown in Figure 40. This area has been repeatedly subjected to sulphur dusting, but no stress symptoms were noted in the pines and spruce. The SO_2 plume from the Windfall plant is shown in Figure 41. Winds were light and variable on the day of observation and point to the structured character imparted to the plume by such conditions. The integrity of the plume was maintained for a considerable distance and the effect of surface inhomogeneities is noted.

Other data are yet to be taken of such plumes and more quantitative conclusions will be possible when these data are complete. It will eventually be possible to infer accurately the nature of the plume from meteorological data only. The dispersion character will be also known as well as SO_2 plume concentrations. This will also permit a more suitable placement of dust fall and sulphation stations.

The above data were taken with an airborne Correlation Spectrometer, (Barringer COSPEC). This instrument is a remote sensing device that measures the spectral shift of ultra-violet due to SO_2. In one mode of operation, the instrument "looks" through a quartz window in the roof, at the plume, and uses ultra-violet from the sun to sense SO_2 as depicted in Figure 42. Alternatively, an ultraviolet source in the aircraft cabin is directed at a mirror system which is mounted on the perimeter of the aircraft. The light returns to the cabin and into the spectrometer by following the

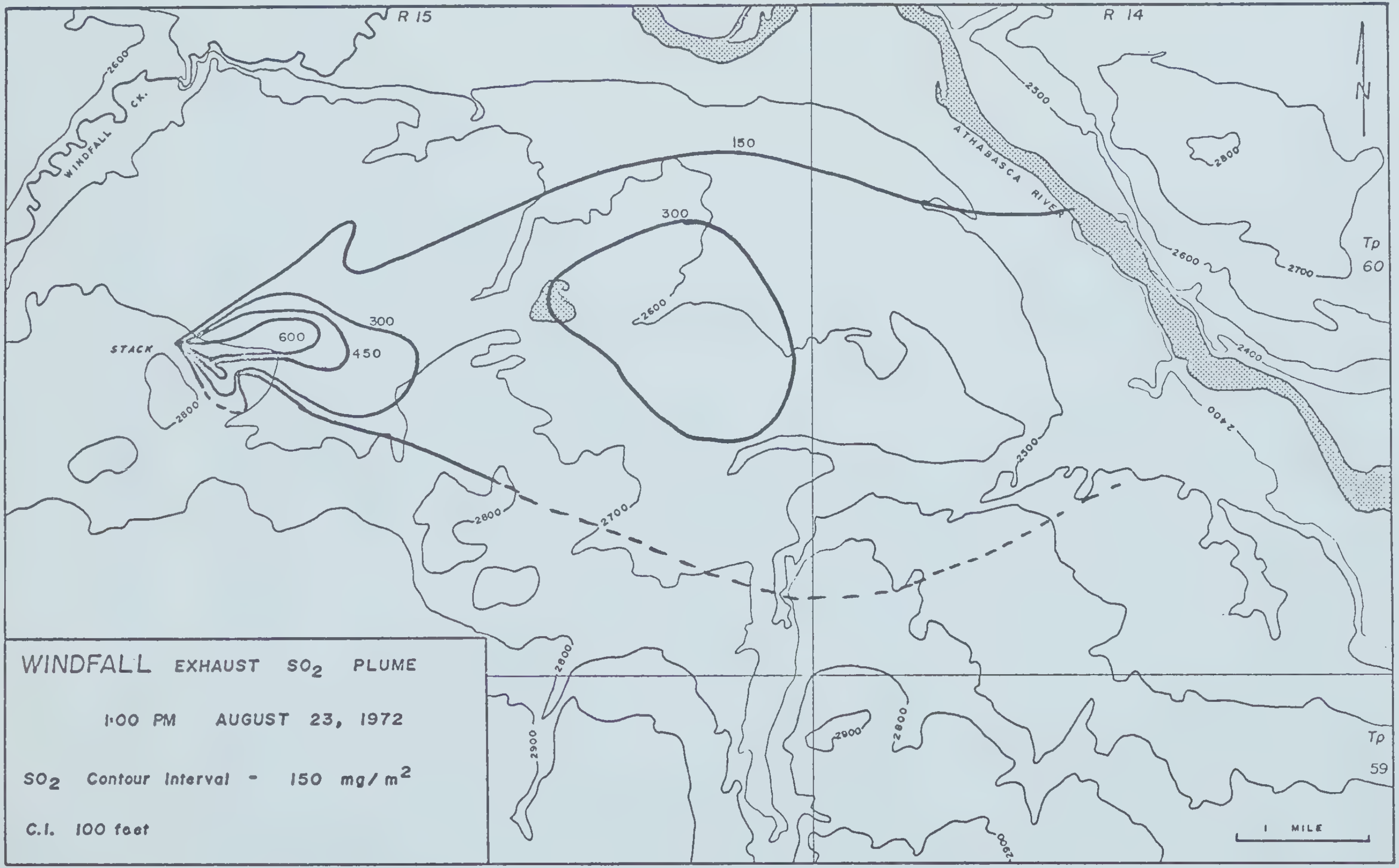

FIGURE 41. WINDFALL PLANT - EAST SO_2 PLUME.

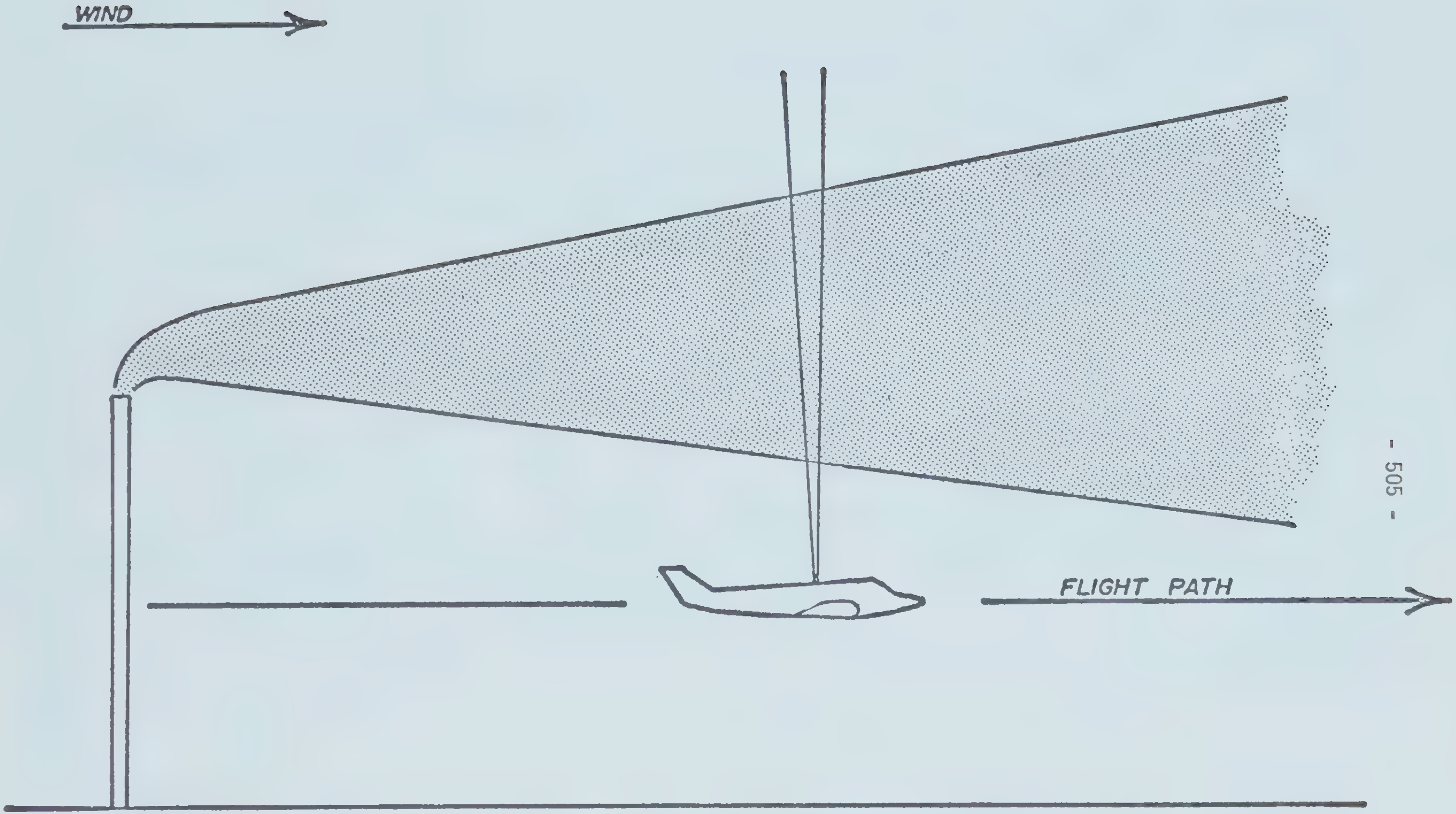

FIGURE 42. Idealized illustration of Airborne Correlation Spectrometer determination of Total SO_2 burden in plume using ambient light.

mirrors. In this mode, the SO_2 in the light path is sensed. This permits measurements at night or in low light conditions. The method is outlined in Figure 43.

Figure 44 is a scene of the gas plant at Kaybob I and II, (Hudson's Bay Oil and Gas). Some of the forest is noted in the southwest corner of the site. These trees were strongly affected by the flare stack, but the stress was very local. Figure 45 is a view of the same corner of the site from a different angle. The trees are showing marked effect of the proximity of the flare stack and the industry generally, but particularly from the herbicide sprays, used near a hydro line. A similar view is in Figure 46 showing pronounced stress in the deciduous. Approximately one hundred yards farther away are small poplars and clover that are unaffected,as indicated in Figure 47. Figure 48 is a view of the high water table area near Smoke Lake. All of the spruce have died and phreatophytic brush remains. The gas plant stacks are visible on the crest of the distant hill.

All prominent ridges, hill tops and muskeg within ten miles were examined carefully for SO_2 symptoms. At only one point to the southeast, shown in Figure 49, were deciduous as well as coniferous trees affected. Very mild stress was indicated along the ridge shown. Elsewhere, only isolated deciduous communities showed mild SO_2 doses.

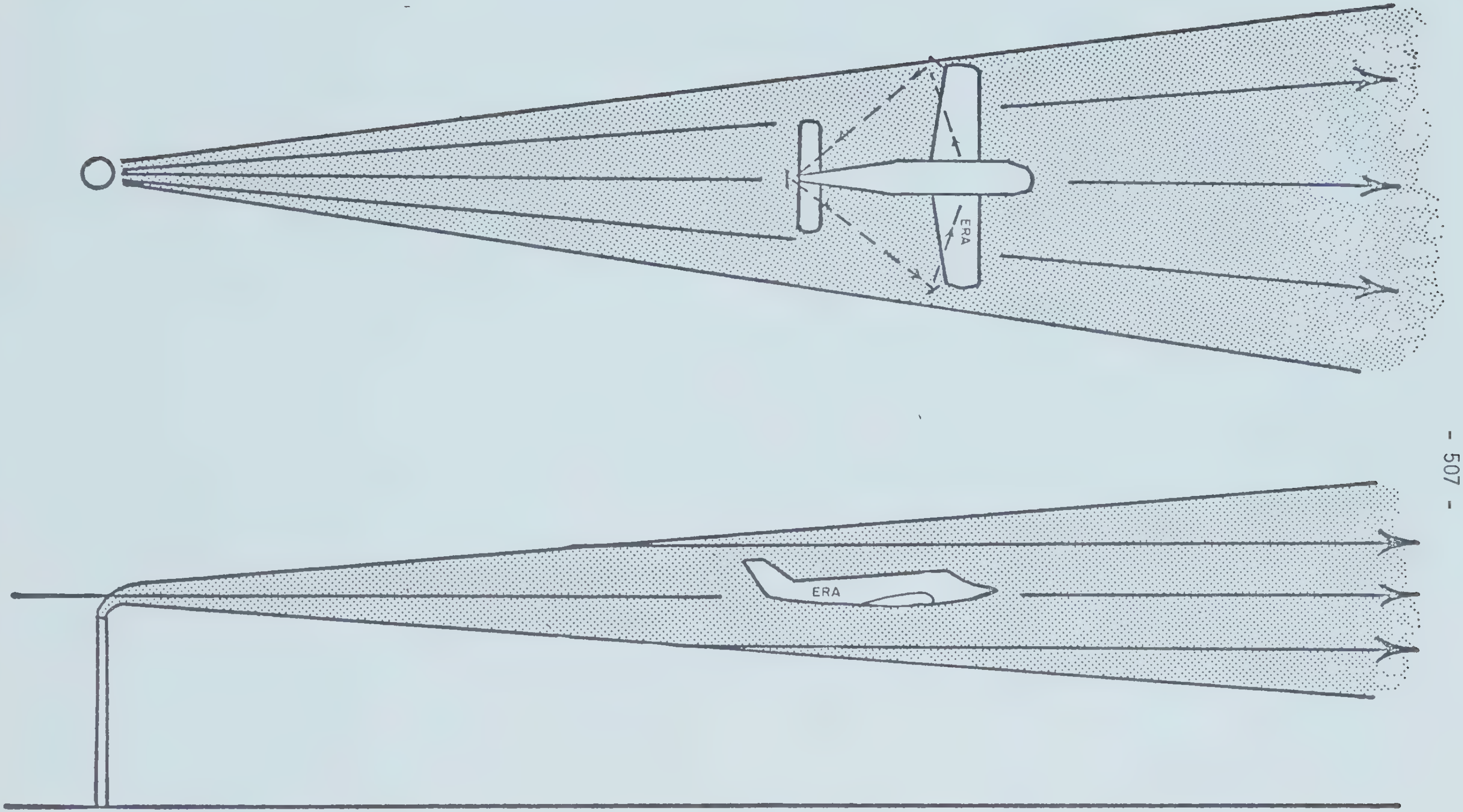

FIGURE 43. Idealized Illustration of Airborne Correlation Spectrometer determination of SO_2 plume profile using closed circuit light system.

The SO_2 plume from Kaybob I and II is presented in Figure 50. Winds were moderate out of the northwest. The plume is elongated with the more concentrated portions extending greater distances than with light and variable winds. The plume is following the ridge where SO_2 stress was noted in the deciduous and coniferous stands shown in Figure 49.

The Kaybob III gas plant (Chevron Standard Ltd.) is in Figure 51 with a looping plume from the flare stack. The plant is situated on a raised portion of terrain with mixed forest on undulating topography and muskeg. The gas plant had been in operation for less than one year when the surveys were carried out. Figure 52 is a view of the growing slated-sulphur storage pile and forested hillside. The trees surrounding the industrial area displayed the same effects as have been noted at other gas plants due to construction and industrial activity (Figure 53). Symptoms of damage under such conditions are normally very complex and not easily categorized as shown in Figure 54. The surrounding forest was examined as were many rights-of-way (Figure 55) to a distance of ten miles, and no SO_2 intrusions were found.

Figure 56 is the SO_2 plume from Kaybob III. Notice that the effluent is highly structured under the light and variable winds encountered. The plume is widely distributed due to variable wind direction. Data will also be obtained on later flights that will cross-structure the plume.

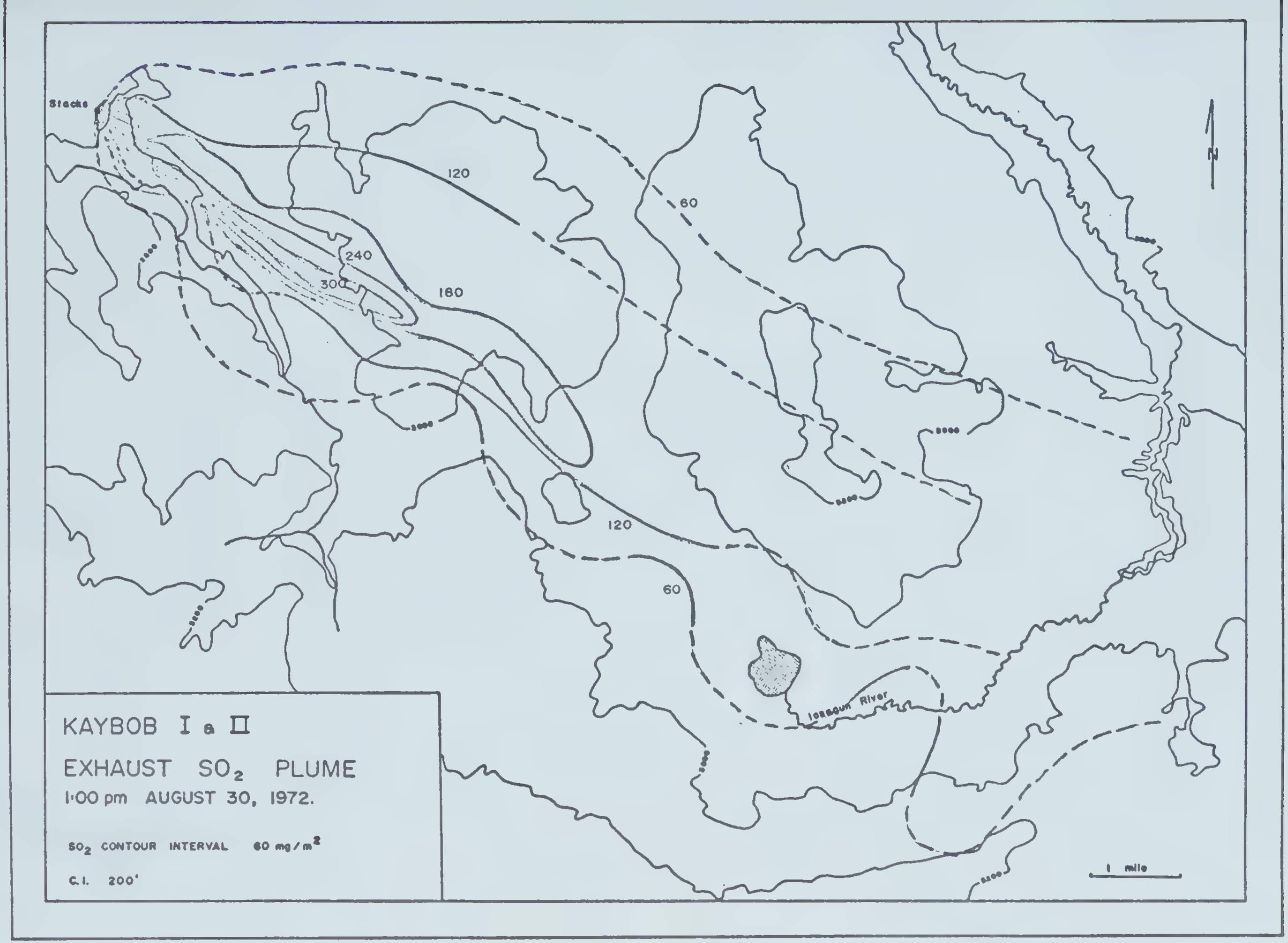

FIGURE 50. KAYBOB I & II SOUTHEAST SO_2 PLUME.

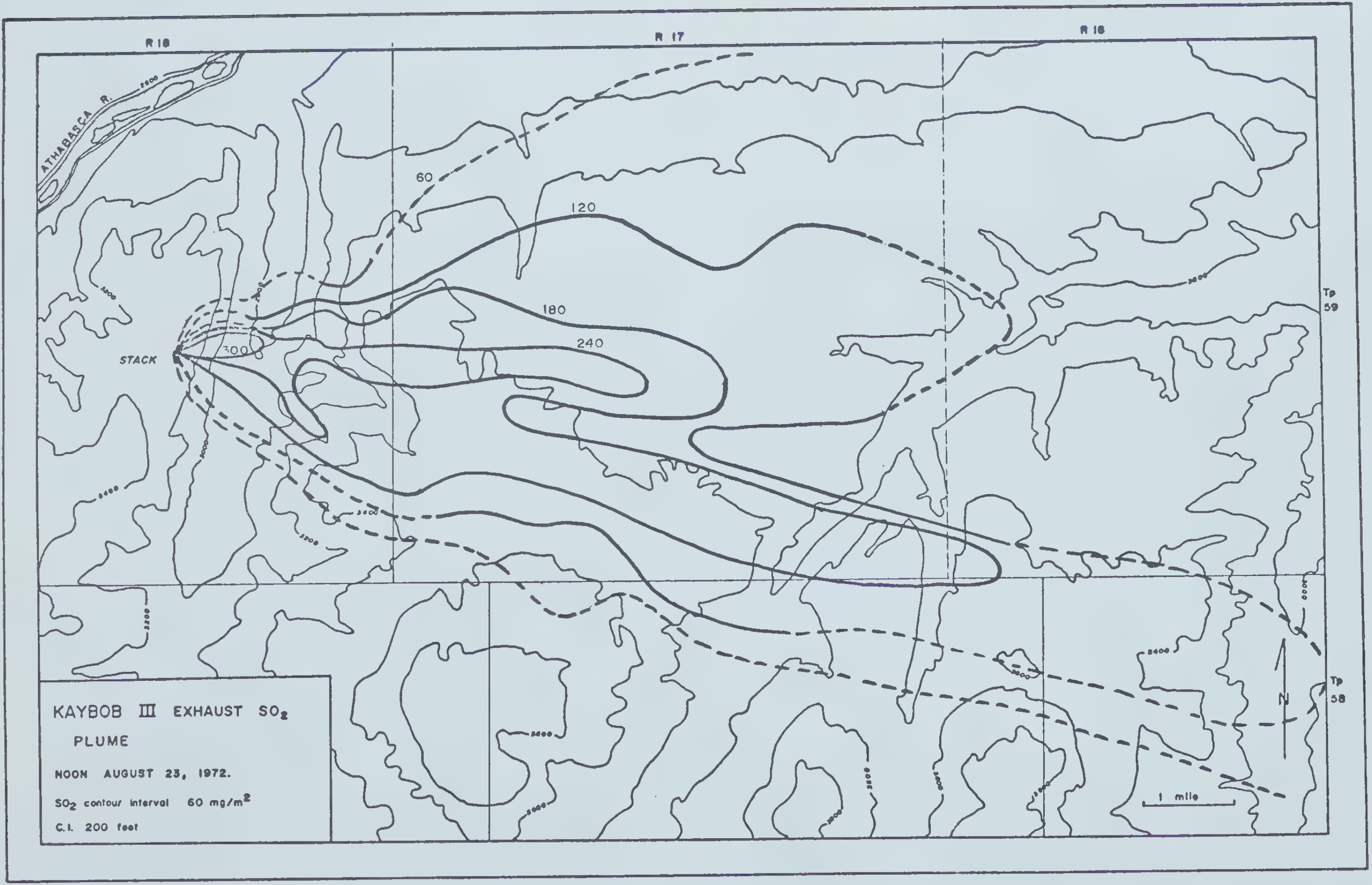

FIGURE 56. KAYBOB III EAST SO_2 PLUME.

The Simonette gas plant (Shell Canada) is presented in the view in Figure 57. The site is located on an elevated portion of terrain with undulating, mixed forest topography and muskeg. A looping plume was noted from the flare stack on the day the photograph was obtained. Figure 58 is a view from the northwest corner of the plant site and shows the perimeter trees in a condition similar to that observed at other plant sites. The poplars and pines in Figure 59 are similarly affected and are located on the eastern edge of the site. An area of mainly deciduous trees to the southeast of the gas plant are shown in Figure 60. These trees were showing chronic SO_2 stress over a wide area. During an inspection three weeks later, no symptoms were noted.

An area of extensive forest "burn" was found about eight miles to the southeast of the Simonette gas plant. The area, shown in Figure 61,was examined in detail. Affected conifers are noted in Figure 62. Spruce are infected by fungus, and pines are showing temperature (Chinook) burn. Nearby, deciduous trees are severely defoliated and isolated pines are burned. No insect infestations were noted (Figure 63). The distress symptoms in this hillside are rather unusual, in that all the different species are affected. The symptoms were not that of SO_2, yet the hillside and area is in a position to receive SO_2 if the plume from Simonette were to be carried in this direction. The buds of the deciduous trees were examined and found to be normal. This area will be examined carefully in the future.

The SO_2 plume from Simonette is in Figure 64. Under the moderate and gusty winds encountered, the plume was very diluted at distances downwind. Near the plant the highest concentrations of SO_2 were lengthened into a narrow plume for about 2½ miles downwind.

The Edson gas plant (Hudsons's Bay Oil and Gas) is located to the west of the town of Edson, very near the McLeod River. The incinerator stack and gas plant are located on elevated terrain which is undulating and covered with mixed forest and muskeg. The trees and brush on the perimeter of the gas plant are stressed in a similar manner to those at other gas plants in the Whitecourt area. These influences are due to the proximity of the industrial activity. Figure 65 is a gradually sloping hillside to the southeast of the gas plant with an even stand of mixed forest species. SO_2 plume impingement has occurred in this forest area and mild SO_2 stress symptoms were noted in the deciduous trees throughout. The stand was examined three times during the season with similar symptoms noted each time. Mild stress symptoms normally disappear if the dosage is light and if the irritant is removed. The transitory nature of SO_2 effect has been noted previously , but since the symptoms were present during each of three separate visits, it is likely that the hillside has been subjected to repeated SO_2 exposures. Figure 66 is a closer view of a portion of the southeast hill, slope, and crest. Note that many of the spruce trees are infected with fungus and the deciduous trees show mild SO_2 intrusion. Pines appear unaffected by SO_2 on other environmental conditions. The plume of the Edson gas plant under light and variable winds is shown in Figure 67. Note the strongly lobed nature of the effluent SO_2. The plume is seen to fan out horizontally and to respond to the changes in topography. The hill to the southeast has the effect "bending" the plume to the east with a strong lobe moving to the south. Plume impingement on the southeast hill was considered likely during this period, but was not measured directly.

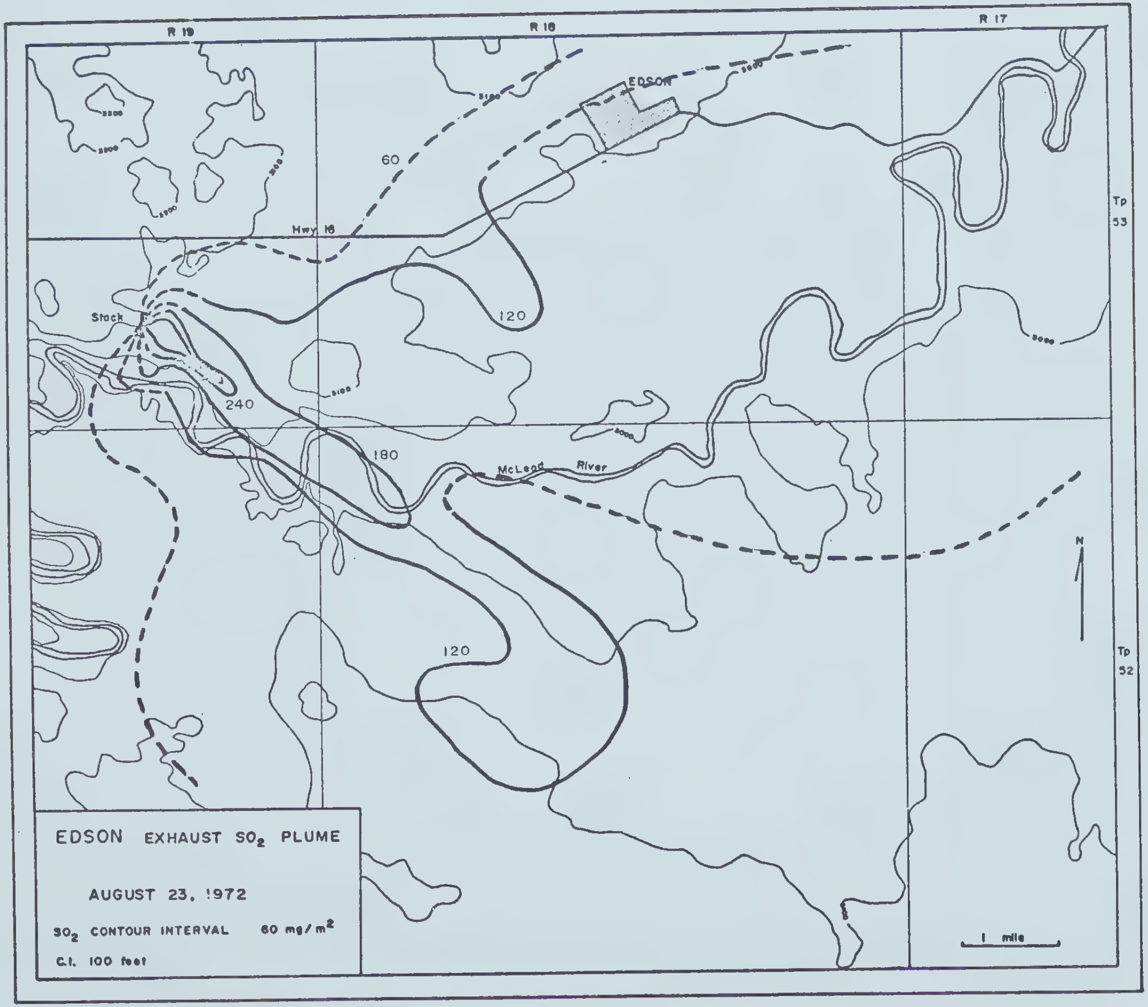

FIGURE 67. EDSON EAST SO_2 PLUME.

SUMMARY

Preliminary data from studies of the environment of several sulphur extraction gas plants has been presented. These results are mainly concerned with vegetation stress and plume dispersion analyses. (The complete study commissioned by the Whitecourt Environmental Study Group involves many more facets of the environment). It was noted that the vegetation surrounding the gas plants on the perimeter of the site was affected by various factors, but mainly showed the effects of construction activities. Vegetation mear many flare stacks had complex stress symptoms, not easily diagnosed. Elsewhere, mild SO_2 stress was noted to predominate in deciduous trees on elevated terrain. Although coniferous vegetation was also influenced by SO_2, the incidence of occurrence was very small. Some areas appeared to have mild SO_2 stress that was transitory, and other stands of trees appeared to come under the influences of the SO_2 plume, more often with more persistent stress in evidence. At no time was SO_2 noted to have caused toxicity in any of the trees examined. Natural stress symptoms were widespread and included spruce fungus, chinook or temperature "burn", insect infestation, as well as other factors that were noted but not identified or diagnosed.

The Whitecourt Environmental Study will continue for up to five years to clearly outline the effect of the sulphur and natural gas industry in this region. It will also provide a data base that will serve the gas plant industry in all of Alberta. The findings will also make it possible for legislatures to realize that control of gas plant operations is a matter that is not simply concerned with the effluents in the stack. It is also critical that the effluents absorbed by the receiving environment be considered!

QUESTIONING BY THE AUTHORITY

DR. W.R. TROST

Mr. Baranuk, I wonder if you could tell us what companies have co-operated together in the Whitecourt Environmental Study Group?

MR. E. BARANUK

There are eight of them: Texas Gulf Sulphur, Amoco, Chevron, Fina, Hudson Bay, City Service, Pacific and Shell.

DR. W.R. TROST

What was the machinery they set up to establish and look after the Whitecourt Environmental Study Group?

MR. E. BARANUK

When you say machinery are you talking about people, individuals? The concern of each of the operators at each individual plants was the effect of the plants on the concentration in the area. We had one delegate from each of the companies that would get together at one meeting and form the group.

DR. W.R. TROST

I found your approach very interesting and worthwhile. Would you describe a little bit how the Environmental Study Group did get its beginning and did move forward to establish its research program?

MR. E. BARANUK

We got together early in March. The concentration in the area of the plant was concerning all the operators and we wanted to get a base case as quickly as we could before any change had occurred as a result of all the plants operating in the area. As you are aware, Kaybob 1 came on three years ago, then came Kaybob 2, then the large Chevron Kaybob 3; Windfall and Bigstone have been operating for ten to five years -- at a river for five or six years.

DR. W.R. TROST

In some way or other the feeling grew among the several companies, out of the individual plant operators I take it, that such a co-operative program of research into environmental effects would be a good idea?

MR. E. BARANUK

Yes, What had been taking place up to this time was that each company was doing its own environmental study around its particular plant; but there was no way of knowing how one plant affected the conditions around another plant, and we felt an overall co-operative approach was the best way to attack the problem.

DR. W.R. TROST

Did you bring community involvement into your planning at any stage?

MR. E. BARANUK

Not at this time, no.

DR. W.R. TROST

Did you consider it?

MR. E. BARANUK

NO, we have not.

DR. W.R. TROST

Do you think it would be in any way helpful to the program to do that?

MR. E. BARANUK

We have asked today for their comments on our findings, and of any way we can be of help in this regard.

DR. S.B. SMITH

Mr. Baranuk, you made the statement in the summary of the comments that the effect from SO_2 emissions appears to be transitory, and yet Dr. Holmes spent some time pointing out that the variability in natural systems is the result of perhaps several millions or several hundreds of thousands of years of evolutionary process. I just wonder how to resolve what appears to me to be an anomaly. Perhaps, Dr. Holmes, you would like to comment on this -- that while the results appear to be transitory, you have been at the business a very short time and the plants and animals have been here a very long time, say 10,000 years, since the last glaciation at least.

DR. R. HOLMES

The effects that we noted to be transitory are those that affect the particular plants on a seasonal basis. For example, if you stress a plant to a point where the plant is just short of death and then remove the stress it will attempt to recover. If I can give the plant some kind of volition, I can say that the plant will try to recover from the stress that has been given to it, so if a community of trees has a dose of SO_2 (regardless of the concentration) and the dosage is removed, and if that dosage has been short of causing the death of the organisms, the plants will attempt to recover and in that sense they are transitory. The passage of SO_2 from a natural plume is also transient. The wind and the environment carry it over and near a given community or a hillside in a transient manner, depending upon the conditions of the plume at that time, and if the stress is removed the plants will certainly begin to recover provided they have not been killed by the initial dosage.

DR. S.B. SMITH

Yes. These are the observable physical effects at that time. I wonder if we....

DR. R. HOLMES

I can address myself to the long-term effects if you wish. Is this of concern to you?

DR. S.B. SMITH

No. I didn't want to get into that so much as to ask you a couple of questions about whether you have been looking at the soils -- the microbiology of the soils.

DR. R. HOLMES

Yes, we have hundreds of soil samples which, due to the preliminary nature of the experiment, have not yet been sufficiently correlated so that I can make a statement beyond this. We have examined the soils, in particular throughout the entire Whitecourt city area. Samples have been taken everywhere that it was reasonable to get samples, in particular concentrated sampling around the sulphur plant itself. We have noted that in mineral soils around the sulphur storage area the effect is very pronounced. Around the soils of this area with a high organic content the effect is much much less pronounced. There is some depression of pH, some concentration of sulphate, some increase in conductivity, and some reduction of free lime concentration, but in general the effect is very much less than it would be in a mineral soil near Calgary, for example.

DR. S.B. SMITH

You are looking at these more from a point of view of static soil chemistry rather than dynamic microbiological relations?

DR. R. HOLMES

Yes, that is correct. At the moment it's true.

DR. S.B. SMITH

Do you have any data on the sulphur-selenium balance and any possible effects it might have on at least three common species of ungulate here -- moose, deer and elk?

DR. R. HOLMES

There are a number of balances of this kind in nature and we have noted one elsewhere with particular regard to calcium and phosphorus balance. There is another -- sulphur and boron have a partiuclar relationship -- but the sulphur-selenium thing is new to us and is peculiar to this particular part where the sulphur-selenium balance problem exists. The ungulate problem with sulphur-selenium in the Canadian shield, for example, is not as pronounced as it is here. They have artificially induced imbalances in nature to see if this has some effect, but it does not. My direct answer to the question is, and I think that I am familiar with the literature on this problem, that there has been no research in this area, on this problem, but we propose to do so.

DR. S.B. SMITH

What about the possibilities of using indicator species such as lichens, which as you know are so sensitive to extraneous chemical influences?

DR. R. HOLMES

I have found it very very difficult to diagnose this stress in lichens. I can see that after pronounced, long-term low-level exposure lichens will demonstrate the stress, but the same kind of exposure in deciduous trees, for example (which are the next order up in sensitivity) is just as easy to diagnose. We have looked at that side of the tree, for example, which has the most lichens on it and have tried to relate that to a vector toward the gas plant to see if this has some effect, and have not noted any effect in this area as yet.

DR. S.B. SMITH

Are you of the opinion that effort should be concentrated on field experiments, doing actual observations at various ground levels away from the plant, rather than in the lab, although I understand the implication of using the lab techniques?

DR. R. HOLMES

I am completely converted to the idea. I don't want to underestimate or devalue the value of laboratory experiments, which are absolutely critical and crucial at some points in the research process, but at this point in time we have almost zero experience with SO_2 stress in the normal environment of Alberta. It is very difficult to see, it is very difficult to diagnose, and it is too easily mistaken for other things.

DR. S.B. SMITH

Do you think you will get close to understanding the total assimilated capacity of the environment you are dealing with -- say 500 square miles roughly --for sulphur or any effluent from the plants? It seems to me that this is what you are perhaps pointing towards.

DR. R. HOLMES

We can make a couple of very elementary statements or preliminary statements about that. There have been some plants here which have been in operation for ten years -- and we have seen plants which have been in operation for much less than that -- and the SO_2 stress which is transitory on a seasonal basis is about the same in both places. So ten years at Windfall, for example, has produced the same kind of a stress that we observe at Simonette, which has been in operation for much less time -- or say at Kaybob 3. It is certainly going to happen that we are going to obtain data over the next three to five years that will enable us to determine what the absorptivity of the environment is of sulphur. We are laying groundwork for this.

MR. W.A. FLOOK

I was particularly impressed with your explanation and the concept of ecological domains. I think it is a very exclusive job. Recalling the slide, the first slide you put on, presumably the patch in the middle represented the closest approach to the optimum combination of all parameters.

DR. R. HOLMES

We wrestled with a diagram that would have been better than that, but we came back to this one.

MR. W.A. FLOOK

The concept came through loud and clear. The part that I am interested in would be the fringes of that diagram, where, presumably, as you move out toward the edges the optimum combination of parameters becomes less productive of the idea.

DR. R. HOLMES

One is apt to get into very serious trouble if he tries to draw sharp lines at those boundaries. I prefer to have them fuzzy, and I prefer to stay as far away from that edge as possible. We know something about the very fine edges where it becomes fuzzy. The closer we come into this area the more we know about it, and this I feel is where we should stay.

MR. W.A. FLOOK

The point that I am trying to get onto is that in these areas, where already conditions are something less than optimum, would it be true that the imposition of another adverse factor, such as SO_2 incidence in the air, might have a more noticeable or more far-reaching effect in these areas than somewhere in the interior, where other conditions were more optimum?

DR. R. HOLMES

Very definitely so. You are leading up to the concept of environmental or biological pre conditioning, which is a well-known biological phenomenon and certainly exists, and this is part of our study as well. We have noted some relationships in this area already.

MR. W.A. FLOOK

Upon looking at the effects of sulphur on the plants in the slides that you demonstrated, in most cases it was the effect of sulphur alone that appeared to be demonstrated -- not the effect of sulphur in combination with any other adverse conditions such as heavy insect infestation. I am wondering whether perhaps some of the conditions that you referred to as mild sulphur stress may in fact have been noticeable or heavy sulphur stress, given a bad chinook or something just before it.

DR. R. HOLMES

In one particular slide, the one on the ridge toward the southeast of Kaybob 1 and 2, there is an area of high water table and a low area with high water tables. The deciduous vegetation went from the ridge top down the slope and onto the flat before it disappeared because of high water tables. The closer we got to high water table stress, the less evident visible indications became. So a plant that is already previously stressed by something else, or previously preconditioned, may be either more or less susceptible to subsequent SO_2 fumigation.

MR. W.A. FLOOK

I see. In addition to the visible signs of SO_2 stress, might there be other effects not so visible, such as reduced growth rate?

DR. R. HOLMES

Oh, yes, very much so.

MR. W.A. FLOOK

Are you measuring these as well?

DR. R. HOLMES

Yes, we are.

MR. W.A. FLOOK

How about effects on other things, such as inanimate properties -- wire fences, paint on houses, that sort of thing? A lot of people in our previous hearings have mentioned this. In fact, it's been mentioned more often than the effect on trees. It seems to hit closer to home.

DR. R. HOLMES

I think people are very hard pressed to show very definite symptoms in trees. I mentioned their difficulty in diagnosing this stress, anyway, but if you have trouble getting a bolt off a machine to fix it because it's rusty, that's very noticeable; if your barbed wire's rusting, that's very noticeable. And anybody who's walked around a flare, or around a gas plant, or anywhere within the city of Calgary, has seen trouble with rust. It's just there, and it's very obvious. In questioning farmers and residents of areas near gas plants, we received indications that these are problems. But in fact, I'm convinced that they're not restricted to gas plant environments; they're part of the business of farming, but they appear to be more severe near the gas plant -- the corrosion problems.

MR. W.A. FLOOK

But you have not in fact established in any direct cause-effect....

DR. R. HOLMES

Negative. We have not done that as yet.

MR. W.A. FLOOK

Are you planning to do this?

DR. R. HOLMES

We have not received a directive to do that. If we had combines and threshing machines and tractors sitting out in this environment, it would be a part of the study, but there's just nobody there -- there are no machines out there,other than the machines of the gas plant itself. These are being studied, but it's rather difficult in this partiuclar ecology -- farther south it would be very definitely a part of our work.

MR. W.A. FLOOK

You indicated short and long-term effects. Would you like to give me some idea of what you consider long-term effects to be? In terms of years, roughly. Five, ten, twenty, fifty?

DR. R. HOLMES

I would say longer than that -- at least ten, fifteen years. There are two kinds of long-term effects that I can isolate at the moment. One is the gradual accumulation of sulphur in the environment to the point where it is no longer acceptable; any additional small dosages cause stress that you would not have noticed maybe four or five years previous because of the difference in levels. The other one is the other problem that we are facing and studying very closely, the one that was mentioned earlier on preconditioning. If vegetation or the environment -- animals, insects -- are constantly, annually, subjected to this particular kind of stress, it in a sense prepares that organism for subsequent invasions by other things. You may not see SO_2 but you'll see an invasion of insects, or rust or fungus; you'll see something else that has been the result of the preconditioning, and this is a very critical part of this study. Those effects could occur annually, I believe, and they could occur during the first year of operation, but I think that we will see them after about five years.

DR. W.R. TROST

In this region there are many factors that are, in a way, specific to it, and you've touched on some of them. One of them that you've also mentioned is that the plants here are relatively new and are consequently being installed with the advantages of advanced technology. And this leads to the result that the actual emission of sulphur dioxide and other materials through the stacks is probably a good deal less than it was in the early days of the sulphur plant business, or in the early days of Trail, for example, where there were substantial emissions. You're really talking about and your arguments apply to that range of conditions in which there is limited sulphur dioxide content in the emission.

DR. R. HOLMES

I think that's true.

DR. W.R. TROST

The reason I wanted to follow this point was to see whether part of the objective of your studies in which you're looking at environmental effects is to feed back into how the control on the plant should be managed to reach these minimal environmental stresses. Do you feel that the control should be in the stacks, or at ground level?

DR. R. HOLMES

I feel you have to have both. I think it's improper, and unscientific and illogical to regulate the whole system based upon stack or emission controls. It's an entirely unscientific and untenable position; this is my personal point of view. However, in the design of the plant, in the design of the engineering part, it's critical to have this input to reach some kind of level. But then, this effluent is ejected into a receiving environment which has enormous variability and enormous capability of absorbing and of rebounding and of diffusing, and all of those nice things. There absolutely has to be, to have any logic connected with our problem at all, an enormous amount of environmental input. It's possible, for example, to adhere to the guidelines explicitly and still have a damaged environment. It's possible to have a plant that far exceeds the guidelines and have a completely clean environment if the environment or the climatology is sufficient to absorb it or to diffuse it. Now we've taken two extremes at opposite ends of the ladder, and I think we have to get somewhere where we have input from both, otherwise we're going to be fighting all the time.

DR. W.R. TROST

In this district, and I'm not myself sure what the meteorology is, but in some conditions -- as in some of the mountain pass areas -- the wind blows pretty well always in one direction, and that tends to avoid proper dilution. Do you have as severe a problem in respect to prevailing winds in this area?

DR. R. HOLMES

Not so much. The wind roses of all the plants in this area are roughly similar. We have a large project on now to determine specifically what these are, but the main vectors appear to be from the northwest and from the south and southeast, and these two vectors cause the distribution patterns to be as they are at the moment.

DR. W.R. TROST

So that you have some localization, but there is also a tendency to disperse?

DR. R. HOLMES

There are many many local effects, or graphic effects, for example.

DR. W.R. TROST

Now, when we were in Pincher Creek, Shell described a research program that they were tailoring to the needs of environmental problems down there. Are you acquainted with it?

DR. R. HOLMES

Only a little bit. I've been brought into it just from the fringes, and I must confess my ignorance,somewhat, of what Shell is doing.

DR. W.R. TROST

Now, the districts are of course quite substantially different. I know that you know the district in the south very well indeed, but do you feel there would be any value in exchanging information between these two research programs?

DR. R. HOLMES

The environment doesn't care whose plant is there or where it is; it just simply goes on, and I think that exchanging information is critical. There's no sense in retracing experiments of similar locations; if we've got a plant problem in the Crowsnest Pass area and we've got one in the Kicking Horse Pass area, a sharing of information can avoid needless expense and duplication of work.

DR. W.R. TROST

Yes. Here you've already touched on the reason for focusing on plants as that's what there is the most of.....

DR. R. HOLMES

Vegetation....

DR. W.R. TROST

Yes, that's right. But wildlife and, of course, human beings are also significant, and it may be that the effect on them either of sulphur dioxide or of other materials may turn out to be significant. Do you have an animal program?

DR. R. HOLMES

Yes, we do. It's part of the program. There's one very serious problem with studying animals, and insects to a certain degree -- fungus and insect spread that carries itself with the climate for example -- and that is, when an animal finds an unfavorable food supply, when it is subjected to an unfavorable environment, whether from SO_2 or from severe temperature extremes, the animal moves -- it goes where the conditions are more favorable. In that regard an animal is somewhat difficult to study, unless you catch it and subject it to an unfavorable environment to study its reaction, because in the normal ecology it simply gets out and goes somewhere it isn't, so it can get along better.

DR. W.R. TROST

How far are the sulphur plants, in this case, from centers of population?

DR. R. HOLMES

They're right in the middle. During part of our summer survey, the moose and deer (we thought we saw a bear but we're not sure), all small rodents, squirrels, and all manner of birds, were moving freely about. We were getting at vegetation problems this summer, and it didn't really permit us to make a very careful evaluation of animals or centers of population or movements this summer.

DR. W.R. TROST

Then there isn't any indication as yet that the animal population is moving?

DR. R. HOLMES

I can't observe any right now. We tried to get hold of a man who lives up in this area who studies this thing all the time, and that was the extent of our real investigation on animals, but it will be a part of the project.

DR. W.R. TROST

How far are the sulphur plants from centers of human population?

DR. R. HOLMES

Well, the closest one, I guess, is Kaybob 1 and 2 -- in Fox Creek, about twelve to fifteen miles. That's the closest one. Edson, of course, is near the outskirts of the town of Edson; and Sturgeon Lake is close to Castleview up north. The closest one -- is it four miles? -- is very close to here. So there are some plants which are fairly close to small communities, but the big ones are at quite a distance.

DR. W.R. TROST

For the most part, the kinds of human activity that are near the plant are not agricultural?

DR. R. HOLMES

In the main, except for places like Paddle River or Greencourt, which are near agricultural areas.

Mr. M. Winning summarized
the Canadian Petroleum Association
brief presented in Calgary

Submission of Chevron Standard Limited

Regarding Environmental Effects of the Operation of Sulphur Extraction Gas Plants, with Particular Reference to the Kaybob South Beaverhill Lake Gas Unit No. 3 Processing Plant.

to

Environment Conservation Authority Hearing

Whitecourt, Alberta, October 11, 1972

Presented by: J. Spring

FOREWORD

Chevron Standard Limited participated in the preparation of and fully endorses the submission by the Canadian Petroleum Association (CPA) which covers in some detail the subject of environmental effects of the operation of a natural gas processing plant with its sulphur extracting facility.

Rather than repeat much of the information contained in the CPA submission, Chevron's submission is restricted to a discussion of the features of the Kaybob South Beaverhill Lake Gas Unit No. 3 Processing Plant which can influence the environment in the area.

Chevron Standard Limited, as operator of the plant on behalf of eight working interest owners, is responsible for maintaining field and plant efficiency and safety at a high level to minimize danger to the plant and field staff, the public and the environment.

Chevron Standard Limited welcomes this opportunity for the industry to present its views. We strongly favor the procedure of consultation between Government, Energy Resources Conservation Board and industry prior to enactment of new environmental legislation and issuance of regulations and guidelines thereunder. Such a procedure served very effectively in the past to establish realistic standards and regulations which have been shown to be effective in protecting the environment. It is our hope that, as a result of these hearings, the roles of the Department of the Environment and the Energy Resources Conservation Board will be reexamined and that the role of each will be clearly defined, their objectives unified and administrative procedures streamlined in the interest of preventing the development of confusing and burdensome multiple standards and controls.

Introduction

Chevron Standard Limited is operator of the Kaybob South Beaverhill Lake Gas Unit No. 3 which includes a gas processing plant comprising LPG removal facilities, acid gas extraction equipment, gas reinjection compressors and a four-stage Claus sulphur extraction plant. The plant commenced start-up in January 1972 and reached its designed level of operation in May 1972. It is one of three processing plants required to process and cycle the Kaybob South Beaverhill Lake gas field and is one of the largest of its kind in the world.

The plant is situated in a remote forest area near the Athabasca River in Section 15, Twp. 59, Rge. 18, W5M, approximately 50 miles north of Edson, 30 miles south of Fox Creek and 37 miles west of Whitecourt.

Consistent with the Energy Resources Conservation Board's approval of the production and cycling scheme for the field, the highest technically feasible and economically attractive sulphur extraction process was designed, including such pollution control features as would meet all regulatory requirements and Company policy, all of which combine to ensure a safe and efficient operation.

The gas processing plant and associated facilities were built at a cost of $108,000,000, including start-up costs. The wells, field roads, gathering system and auxiliary field equipment cost an additional $34,800,000 and main roads and bridges were constructed at a cost in excess of $1,650,000.

In order to house Chevron Standard Limited operating personnel, 96 housing units were built at a cost of $2,500,000 and 24 apartment units were leased. The addition of 120 employes with their families into this community of 1,500 people and the total project expenditure of $147,000,000 represents a sizeable contribution to the economy of the district and of the province.

The gas plant was designed to process 445 million cubic feet per day of raw gas feed with daily production of 32,000 barrels of stabilized condensate, 18,000 barrels of mixed liquid petroleum gases, 3,100 long tons of sulphur and 54 million cubic feet of sales gas. The remaining 230 million cubic feet of stripped residue gas is reinjected for the purpose of increasing the ultimate recovery of liquids and sulphur from the reservoir. This reinjected gas will be produced for market upon completion of the cycling phase of the project.

During the last few years, the world-wide sulphur market has become saturated and prices have fallen drastically. Large sulphur inventories at the plant site must necessarily accrue until world demand again approaches supply which is not expected to occur for at least a decade. In spite of this burden, the safe production, transporting, handling, and storage of sulphur remains a constant concern in terms of economic and environmental conservation.

Environmental Control Measures

In turning our attention to the matter of environmental protection and outlining our control program, it is significant that nearly $10,000,000 of direct Kaybob No. 3 project costs are attributed to pollution control equipment in the field and plant, not including the $1,500,000 invested in a 465 foot waste gas incinerator stack. In addition to 24 hour operator surveillance of environmental control measures, a safety coordinator has a full-time responsibility for field and plant safety, and a process engineer has full-time responsibility to optimize the plant's sulphur recovery within the technological and operational capabilities of the existing facilities.

Following are details of specific efforts to date and plans for the future in environmental protection.

1. Concurrent with the period of field development and plant construction, a program of air monitoring, water analysis of rivers and streams, soil and vegetation analysis was maintained, to assure that we had an adequate base study of the environment in which this new industrial giant was to become a part.

2. The sulphur plant process is monitored and controlled on a 15 minute frequency by tail gas chromatographs. The data from these units and other data are processed by the plant computer and the sulphur recovery efficiency and sulphur dioxide emissions are computed and printed out every half hour as a ready check to ensure that the plant is operating above a level of 96.6% efficiency as approved by the Energy Resources Conservation Board. The composition of the waste gases going to the incinerator is thus also maintained within safe limits. Current sulphur plant recovery efficiency is in the order of 97.2%.

3. In addition, the gas plant incinerator stack effluent is to be continuously monitored on an infrared instrument to assure that the quantities of sulphur dioxide being emitted are within the allowables provided for by the plant approval. The necessary equipment is presently on order and is expected to be installed and operational by year end.

4. The 465 foot stack was designed to disperse the emitted sulphur dioxide waste gas, such that the allowable ground level contamination provided for in the Alberta ambient air quality standards will not be exceeded at tree top level.

5. A program of 33 fixed location hydrogen sulphide and sulphur dioxide monitoring stations is maintained, and results are analyzed every month. These stations located in a 180 square mile area centered on the plant, provide knowledge of the ground level patterns of waste gas emission concentrations, and also determination as to which areas might be more predominantly affected. The Department of the Environment also maintains its own monitoring program for the area.

6. In addition, a trailer is maintained with continuously recording instruments which monitor hydrogen sulphide and sulphur dioxide concentration at the trailer location. These data show a continuous record of the level of air pollution and are filed with the Department of the Environment monthly.

7. Dust fall monitoring stations are also deployed to measure airborne sulphur dust at 12 locations surrounding the plant and sulphur storage and handling area. In order to specifically eliminate a sulphur dust problem, a sulphur slating system has been installed, for the further protection of the environment. The overall objective is to prevent soil imbibition of sulphur dioxide, as well as sulphur dust carryover into any water systems either in normal or flood times.

8. An aerial photographic survey has been completed of some 180 square miles surrounding the plant site using black and white, and false colour infrared photography in order to establish the present condition of the area and to have a standard for the future to assess the long term effect of the plant on the environment. An aerial true colour photographic survey will be completed early next summer.

   We are also participants in the Whitecourt Area Environmental Study Group which has undertaken a similar survey over approximately 1,300 square miles and covers 12 sour gas processing plants operated by eight individual companies. It is our understanding that a progress report on the findings of this study are to be presented at this hearing.

   It is hoped that these programs will provide a convincing record of effective environmental control.

9. Water is a very important part of the environment, and at the plant it is utilized and/or handled and disposed of from a number of sources as follows:

   (a) Water produced along with the gas from the reservoir is separated and, being high in salt content, is injected to the Windfall D-3 reef.

   (b) Water for operation of the various processes and for steam boilers is obtained from the Athabasca River by pipeline. Upon discharge from the process area, it is impounded, filtered and injected into approved subsurface disposal wells.

   (c) Plant process area runoff waters, since they might contain toxic materials, are similarly impounded and injected.

(d) Sulphur storage area runoff is impounded, tested, treated if necessary and, following Department of the Environment approval, released to surface drainage.

Thus, all water from the environs of the plant is safely disposed of as a pollution control measure.

10. A soil erosion control and reclamation program has been adopted, with efforts to date showing exceptionally good results. Eighty per cent of the areas to be reseeded have been completed, with the remaining portions to be attended to as weather conditions permit. Where normal reseeding practices are not successful, we will use the more sophisticated reseeding methods available.

Conclusions

1. The Kaybob South #3 Sulphur Extracting Gas Plant is designed to economically deliver available supplies of fuel energy to markets, using the most up-to-date technology available, consistent with economically attainable efficiencies and currently approved emission control regulations.

   We have met the requirements of the governmental regulations designed to protect the environment and have built in the necessary controls to monitor operations and assure that the plant not only operates at maximum design efficiency but does not exceed the pollution standards.

2. We are presently engaged singly and jointly in research projects aimed at increasing our technological expertise in sulphur extraction, handling, storing and transportation, so that we may apply this knowledge for an increasingly more efficient and economic operation.

3. We believe that the Kaybob South Gas Plant #3 not only represents a very significant addition to the Alberta economy and particularly to the economy of this region but is also compatible with the ecology and the environment. In order to maintain this compatibility, we will operate only in a prudent and safe manner and will provide sufficient evidence on a continuing basis that the environment is not being adversely affected, on either a short term or long term basis.

4. We further point out that very positive effects on the local environment may well result from:

   (a) The increased access to hunting, fishing, boating and other recreational pursuits by virtue of the roads to resources that have been developed.

   (b) The high quality airstrip available to the Forestry Protection Service and the water pumping capability to supply ample water at the airstrip for water bombers.

   (c) The availability of additional all weather roads for access in forest fire fighting emergencies so that our forest resources may have a greater opportunity for survival.

5. We take this opportunity to again direct your attention to the CPA Brief which, on behalf of the natural gas processing industry, will specifically provide facts and expertise on sulphur dioxide as a potential contaminant as well as a potential invigorant to the environment. We fully subscribe to their findings, conclusions and recommendations, and hope that the submission will be useful to the Government and to the Public in further development of an acceptable balance to be achieved in industrialization and environmental protection.

We believe that the Kaybob South Beaverhill Lake Gas Unit No. 3 gas processing and sulphur extracting plant exhibits a positive effect on the community as a whole and that further efforts to restrict sulphur dioxide emissions beyond the design approvals at this plant are neither warranted nor realistic in the face of present scientific evidence. We contend that each gas processing plant with sulphur extraction facilities is unique and design and operations approvals should continue to reflect its uniqueness. We do not agree that each such plant, regardless of its location or nature of its operation, should be subjected to a stereotyped set of requirements but, rather, its unique situation should be taken into consideration when contemplating the imposition of standards.

The policy of Chevron Standard Limited is to improve the existing facility to its maximum capability. This will more than meet the stringent environmental regulations, and notwithstanding upsets that may press upon the allowable limits from time to time, or such shortcomings that may stress efficient operations, we will resolve our internal operating and external environment problems as promptly and expeditiously as possible in order to assure an acceptable and resourceful economic unit in the community.

As conditions change and the need for adjustments in acceptable standards becomes apparent, we look forward to a continuing involvement and an intensification of assistance to government, industry and the public alike, in reaching whatever levels of environmental purity are appropriate and consistent with good practical environmental, technical, and economic parameters.

Protecting the environment is everyone's business. Since we operate this gas plant and work and live in the area, maintaining a healthy environment is very much our concern. We will continue to utilize the latest and most effective equipment and procedures to minimize the danger of pollution and will use all reasonable means to avoid disturbing the ecology of the area so that it will be maintained in a healthy state for all to enjoy.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Is it true that a very large percentage of the people who work in the industry and in your area are oriented to the outdoor recreational picture of hunting, fishing, boating and that kind of thing?

MR. J. SPRING

Yes, I would say that is true. That's one of the ways we have attracted people to work in this area -- because this is significant to them and a plus factor for their coming to live in this area.

DR. S.B. SMITH

Two questions -- first of all, do you offer special training courses for environmental control? Secondly, how important are the actual plant workers in effecting good environmental control? Does their orientation to fish and wildlife make them more aware of the necessity for it? These are all interrelated questions.

MR. J. SPRING

Our training programs stress good operation, and good plant operation is a controlled operation, which means that we are controlling the plant and protecting the environment. As far as the orientation of our people -- yes, I have quite a bit of interface with our people, with individual operators on an individual basis over their concern for the environment, and they are concerned. They criticize us and themselves at times for actions that might damage the environment.

DR. S.B. SMITH

Obviously many thousands of dollars have been spent by companies on making presentations to our hearings, which are now three-fifths of the way through. What is the feeling of the industry --you must have talked about this with other officials -- coming to these hearings and exposing itself to free public comment through the press, radio and television, where you only get maybe a word out of context or a sentence out of context once in a while. It's of interest to us to know how the industry feels about exposing itself in this fashion?

MR. J. SPRING

I may be answering somewhat from a personal point of view, but I feel it is important. I have just finished reading "One Small Earth", the Barbara Ward and Glenetta Bow presentation to the environmental conference in Stockholm, and I think some of the aspects of that book rather graphically bring out our feeling that we are all in this together and that the actions of the oil industry affect the whole community. The oil and gas industry is dependent upon the community for its income, and we are selling to the community, we are part of the community. So we have to interface widely in the community in order to fulfill our overall obligations.

MR. W.A. FLOOK

You indicate that about $10 million of the investment in the Kaybob 3 project was devoted to environmental control equipment. Would you like to tell me something about what type of equipment that was?

MR. J. SPRING

This includes our water disposal, wells, approximately nine miles of pipeline to those wells from the plant, pumping and filtering facilities, tankage, steel tankage at the plant, retention ponds, separators, several sewer systems throughout the plant to segregate and direct waste water, separation facilities to degasify our produced water to decrease the amount of H_2S evolved, and we include the 465 ft. stack in that number too.

MR. W.A. FLOOK

It does not in fact include your sulphur recovery equipment.....

MR. J. SPRING

No, it does not.

MR. W.A. FLOOK

Or equipment for injecting waste gas or waste water back into the formation for the purpose of additional recovery?

MR. J. SPRING

We have no waste gas as such, and that is part of the project; it does include the cost of injecting the waste water into the disposal well, in that we are injecting the water into a different formation than that from which we are withdrawing it, so it's strictly disposal.....

MR. W.A. FLOOK

I see, it's not in fact a producing thing. I'm not trying to split hairs, but there is a fuzzy line between what is out-and-out environment control equipment and what is in fact contributing to the general profitability of the plant. The figures seemed high on the face of it, and I just wondered, but in fact you do have quite a considerable amount of equipment.

MR. J. SPRING

Yes, we do.

MR. W.A. FLOOK

I would like to explore another area just a little bit, mainly because it is such an important thing for the public to realize. When you quote figures for efficiency, you do in fact go to a great deal of trouble to arrive at those. You indicate that you have gas chromatographic instruments for monitoring your tail gas, and that these results are fed into a computer along with other data. Would you like to run down briefly on the process -- what type of other data? How do you in fact arrive at an efficiency figure, so that you can say with confidence that you are complying with the Energy Resources Conservation Board's requirements?

MR. J. SPRING

I think the question is clear -- I'm just trying to run down in my mind the input ......

DR. W.R. TROST

I think it's unfair of Bill to ask the question and answer it himself, however!

MR. J. SPRING

The tail gas chromatograph calculation samples the tail gas from each of the two sulphur trains -- there are two independent systems, two independent chromatographs. The chromatograph draws a sample of the tail gas, runs an analysis and analyzes for sulphur dioxide and H_2S. Then we also take values of input into the front end of the sulphur plant of air and acid gas flow, as well as the balance of the sulphur production, and with some assumptions involved in this equation (there would be some entrainment assumptions -- sulphur entrainment and COS, CS_2 entrainment) these values are fed into an equation in the computer and it generates efficiency based on input-output of the plant.

MR. W.A. FLOOK

When you say you have an efficiency of 97.5 percent, let's say, there is some degree of error in that statement?

MR. J. SPRING

Yes.

MR. W.A. FLOOK

Based on these assumptions, would you say it's half a percent?

MR. J. SPRING

I would say it's less than half a percent. I don't have a specific fact at my fingertips, but we have run error calculations on these equations based on the maximum extent of the error that these assumptions we are making would incur, and I would think that the error assumption is something in the order of 0.2 percent, provided the data we are acquiring are good data.

DR. W.R.TROST

In the last sentence of your Foreword you say, "preventing the development of confusing and burdensome multiple standards and controls by government". Are there any "confusing and burdensome multiple standards and controls" now?

MR. J. SPRING

I feel that we are approaching this point in some of the controls or restrictions that we have in our plant operation at the present time. I think at least one or two of the previous speakers have alluded to this situation. What I'm referring to is the level of emissions of the plant which is basically set using a ground level concentration standard, the use of the calculation program to develop the stack and, I think not unrealistically, a maximum stack effluent of SO_2 on a half-hour basis. One is somewhat a guard against the other. In addition, we have approval to process 445 million cubic feet of gas per day on an annual basis. Additional restrictions on the plant are: we may not feed more than 81.3 million cubic feet a day of hydrogen sulphide to the plant, and our approved efficiency is 96.6 percent. If we exceed our approved efficiency of 96.6 percent we are necessarily considerably below our maximum allowable sulphur stack emission, but we are not permitted to take economic advantage of any improvements we can make in our plant operation by increasing our throughput, by virtue of the fixed limitation on input to the plant on a daily basis.

DR. W.R. TROST

Are you suggesting that some of the regulations are incompatible with each other?

MR. J. SPRING

I'd say they're somewhat contradictory, yes.

DR. W.R. TROST

Is the condition that each applies in a fixed way, rather than there being some ambiguity that the strictest, or the least strict applies?

MR. J. SPRING

The strictest will apply.

DR. W.R. TROST

If the strictest will apply, elaborate on the incompatibility; I think there was some incompatibility even if the strictest applied.

MR. J. SPRING

The strictest restriction we have at the moment is 81.7 million cubic feet of hydrogen sulphide to the plant. If we were achieving our 96.6 percent allowable sulphur plant efficiency, that would permit us to emit to the atmosphere our approved maximum quantity of sulphur dioxide or sulphur compounds.

DR. W.R. TROST

And that is also a fixed or a stated amount, is it?

MR. J. SPRING

Yes, it is.

DR. W.R. TROST

What is that amount?

MR. J. SPRING

It is 107.2 long tons per day. We cannot operate the plant or take advantage of operating the plant at a higher efficiency by virtue of the limitations on the input.

DR. W.R. TROST

You also have a restriction on the concentration of SO_2 in the stack?

MR. J. SPRING

Not of concentration of total volume -- on a half-hourly basis.

DR. W.R. TROST

Roughly, what are the parts per million of SO_2 in the stack under normal operating conditions? I'm sure it will vary somewhat but....

MR. J. SPRING

I don't remember the number, not in parts per million of SO_2.

DR. W.R. TROST

What's the percentage of hydrogen sulphide in your feed gas?

MR. J. SPRING

It is averaging 19.2 to 19.3 percent.

DR. W.R. TROST

You made some reference to economics in your submission. You have set up a fairly new plant and therefore it is presumably more favorable for you to try to break even or make money on sulphur extraction. Is your sulphur extraction under these present conditions a profitable operation, assuming you could sell it?

MR. J. SPRING

I can't answer that question because I don't know how much it costs to produce sulphur.

DR. W.R. TROST

What percentage of the sulphur that you are now extracting are you in fact selling, and what percentage are you stockpiling?

MR. J. SPRING

We are stockpiling 100 percent at the present time.

DR. W.R. TROST

I think what we are talking about now does tie in with your statement about the need to consider each plant as unique. Do you want to elaborate on why you make the claim that each plant should be considered unique? The implications are that regulations and legislation should therefore be very flexible, presumably.

MR. J. SPRING

We accept certain environmental standards that have to be met by virtue of a plant's location or its process. There may be several conditions which allow it to operate and meet the environmental standards without completely complying with all other regulations that might affect the plant, and there may be conditions which would require a higher degree of restriction to certain aspects of the operation because of the uniqueness of the plant. We feel that each plant, each operation, should be viewed as an individual entity with regard to its effect on the environment.

DR. W.R. TROST

I think you make the proposal in your submission that control should be based on ambient air quality standards, rather than on conditions in the stack. Why do you not wish to have a control based on the condition in the stack?

MR. J. SPRING

I don't think we reject the emission control in the stack; we believe that the basic control should be ambient air quality standards. We concede that in order to protect the area it is probably desirable to have some limitations on the stack effluent because on a short term basis it is not possible to detect all air ambient conditions due necessarily to effluent from the stack, and I believe we concede that there should be some maximum limitation on what goes to the stack.

DR. W.R. TROST

Now we are in the situation in which guidelines are proposed by the Energy Resources Conservation Board that are to become more restrictive in the future. Are you having any difficulty with meeting those guidelines?

MR. J. SPRING

We believe we will have difficulty meeting the guidelines. We are embarking on a program of evaluation of our plant to determine whether we can, with the existing facilities and by optimizing the existing facilities, meet those guidelines. We may or we may not be able to meet them. We think we can come quite close.

DR. W.R. TROST

And this will require the installation of an additional treatment plant or some equivalent?

MR. J. SPRING

We believe we can approach or come very close to the guidelines without the addition of tail gas cleanup process, by virtue of the fact that we have a four-stage Claus process. We are one of the few plants that have a four-stage plant.

DR. W.R. TROST

You think you can just control it in such a way that you might meet these projected guidelines -- is that right?

MR. J. SPRING

Yes. We are hopeful that by optimizing the control of the plant and by making operating adjustments we can come close. We are not sure that we can meet it or not.

DR. W.R. TROST

In the last paragraph of your submission, you say "protecting the environment is everyone's business", etc. You are yourself a participant in the co-operative research program which was described before. Do you feel there would be any benefit if, in addition to the companies, there was a community present in that co-operative research program, both to help to define what the program should be and also to help to evaluate......

MR. J. SPRING

I think it would be worthwhile in view that the community would have an opportunity to put into the project the concerns of the community and to develop aspects of the project that would cover those items of concern to the community.

TOWN OF WHITECOURT

September 18th, 1972.

Government of Alberta,
Environment Conservation Authority,
9912 - 107th Street,
EDMONTON, Alberta.

PUBLIC HEARING
WHITECOURT, ALBERTA
October 11, 1972
Presented by: Mayor J. Dahl

BRIEF TO THE ENVIRONMENT CONSERVATION AUTHORITY INVESTIGATING ENVIRONMENTAL EFFECTS OF SULPHUR EXTRACTION GAS PLANTS.

Within a fifty mile radius or the Town of Whitecourt, there are eight gas plants processing sour gas. The majority of plants are located north west of the Town of Whitecourt thus placing the residents downwind relative to the prevailing winds. One plant is located approximately four miles east of the Whitecourt town limits. A number of sour gas wells are being produced within or very close to the Town limits with the gas being transported by pipeline to a gas plant.

With the relatively large volume of gas being processed and resultant flaring of some sour gas, there does not appear to be any detrimental effect on the health of humans or the immediate environment in the Town of Whitecourt. The Council of the Town of Whitecourt respectfully offers the following suggestions for future development considerations:

1. That the Town of Whitecourt be consulted with respect to environmental factors as they may affect the Town prior to

approval being granted to future gas plant development in the Whitecourt area.

2. That methods of transporting sulphur by railroad be improved to prevent loss of the product along with railroad right-of-way which passes through the Town of Whitecourt.
3. That steps be taken to eliminate use of sour gas in the operation of gas wells and pipeline facilities in populated areas to eliminate odors.

Respectfully submitted,

TOWN OF WHITECOURT

per: M. J. Schmitke,
Secretary-Manager.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

We have heard at three hearings of research programs carried out by cooperatives or by individual companies. I wonder how you felt about the Town perhaps being involved, at least as an observer, in these kinds of research programs which are very sensitive and very complicated. As a matter of dissemination of public information, do you think the Town of Whitecourt could act as the focal point for other small villages, which are common throughout this area, in concert with the companies?

MAYOR J. DAHL

I think this would be very good, because I think we should as a Town be more directly involved with regards to having a say in the location of plants in the future. Perhaps representation from the Town could be included in this. I believe it would be good.

MR. W.A. FLOOK

I wonder if you would elaborate a little on the third recommendation, that steps be taken to eliminate the use of sour gas in the operation of gas wells and pipeline facilities. Do you eliminate the production of sour gas?

MAYOR J. DAHL

No, perhaps in the use of sour gas in the well head operations, such as in their separators and line heaters. In most fields sweet gas is used, and then of course you don't get a noxious odor . I think the odor was the biggest reason we included that in there. We have this problem adjacent to Whitecourt in a couple of wells.

MR. W.A. FLOOK

Where they are using sour gas for heating at the well head?

MAYOR J. DAHL

Yes, that's right.

MR. W.A. FLOOK

Have you in fact approached the companies to ask if they would change this practice?

MAYOR J. DAHL

Not officially, but it is coming.

DR. W.R. TROST

You make reference to odors; are odors frequently noticeable in Whitecourt from the sulphur aftereffects of these things?

MAYOR J. DAHL

I don't think we can say that it is all the time. I think perhaps that if the prevailing winds happen to be blowing at that time of day, those living downwind and any public recreational facilities that may be downwind will be where the problem is. We can't say it is all the time, so perhaps it is something to do with the operation, maybe unlit flares, I don't know.

DR. W.R. TROST

Now you say in your brief that there haven't been any health problems. Have there been any other complaints from the citizens relating to these matters?

MAYOR J. DAHL

No. A couple of years ago there was a complaint about sulphur being in the air and being brought down by rainstorms, this kind of thing. Now a study was done by Texas Gulf Sulphur with regards to this, and in checking with the Department of Lands and Forests it was a pollen from trees, or a type of tree, at that time of year -- it wasn't anything to do with sulphur at all. With regard to the other part of your question, we brought this before the Council on three different occasions, three different meetings, and I asked the Councillors if they would check with all the citizens they had the opportunity to speak with and report anything that they may find back to the meetings. Now in the three meeting periods, that covered a six-week period, we didn't have one report back from any Councillor that he had received a complaint from any citizen that he was adversely affected by the plants in this area. I think this is indicative of something.

DR. W.R. TROST

It certainly is -- no complaints from women about their silver tarnishing and that sort of thing?

MAYOR J. DAHL

No, nothing at all.

DR. W.R. TROST

In your first recommendation you suggest that the Town of Whitecourt be consulted with respect to environmental factors. Do you want to elaborate on that any further?

MAYOR J. DAHL

Only if perhaps a gas plant was going to be established in the immediate area. Prevailing winds here are west-northwest, and perhaps the most advantageous location to the industry would be the shortest distance from the field, naturally, for the cost of pipeline. If it was going to be established upwind from the prevailing winds, perhaps representation from the Town would sway them to say, okay, put it on the downwind side, which would mean only a little more added to the pipeline cost. This is why we should be consulted, I feel.

DR. W.R. TROST

And in the past there hasn't been any formal or informal consultation?

MAYOR J. DAHL

No, none at all.

DR. W.R. TROST

I wouldn't mind a little elaboration on your second recommendation as well -- the sulphur dust that is presumably blown off when material is being transported. Is that what the objection is to?

MAYOR J. DAHL

No, I don't think the problem is the dust. I think it is the method of transporting it in bulk, in the block; it's crushed and loaded into open gondolas. I don't think the problem is that it falls off the gondolas in the interior, in the load. It's along the outside edges, where you have a ledge on the railroad cars where there may be some lying, and it's deposited along the railroad right-of-way when the train is switching -- this kind of thing. It is in Whitecourt where most of the railroad switching is done; this is where you get the shunting of the cars and this is where it would fall off.

DR. W.R. TROST

Does it do damage there -- is it blown around?

MAYOR J. DAHL

No, I don't think there is any damage except that over a long period of time you may have quite a considerable quantity, and you cross a number of streams with the railroad. I think just a little more care taken in the loading process, perhaps cleaning the cars a little bit......

DR. W.R. TROST

Now, I understand that some of the companies are either moving towards slating or are doing slating instead of pouring the sulphur and breaking it and crushing it. Does that help in this particular problem that you are describing?

MAYOR J. DAHL

Yes. I am not involved in the industry and I'm not too aware.....however, I did talk to a number of people involved in this, engineers, and the slating process apparently -- now this is merely what I have been told -- is good if you are going to load it and transport it within a reasonable length of time after it is stockpiled, but if you are going to leave it stockpiled for a long period of time it is better to have it in the block because of the slating process. Underneath it has to be crushed somewhat, and a lot of dust particles and the water would filter through from the rains and you might get more pollution from that than if you had it in the block. This is merely what people have told me, I'm not familiar with it at this stage.

Mr. J.W. Andrews summarized the
French Petroleum Institute brief
presented in Pincher Creek

Submission to the Environment Conservation Authority

West Whitecourt and Bigstone Plant Operations

October 11, 1972

Whitecourt, Alberta

Presented by: A. Neidermayer

Amoco Canada Petroleum Company Ltd.

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I. SUMMARY

The purpose of this brief is to review the operations of the West Whitecourt and Bigstone Plants, showing the improvements that have been achieved by the owners in reducing contaminant emissions. Further, it will show the results of our environmental monitoring programs, and make recommendations such that the Environment Conservation Authority may suitably advise the Department of the Environment regarding operations of these plants.

The main potential pollutants are sulphur dioxide emitted from the sulphur recovery process or sour gas flaring and liquid wastes. These plants were designed to effectively handle the contaminants. Further improvements have been made and we will continue to attempt to reduce these emissions to a minimum.

Besides the normal pollution monitoring required by the regulatory authorities, the owners of the West Whitecourt and Bigstone Plants are participating in a comprehensive long-term environmental monitoring program for this area.

To date the evidence from our investigations indicates that the environmental effect is mild and temporary even though the West Whitecourt and Bigstone Plants have been in operation for ten and five years respectively.

We plan to continue this monitoring, expanding the program as necessary to ensure that our operations cause no unacceptable effect on the environment.

We have concluded that with the present state of the art of tail gas cleanup, the increase of sulphur recovery cannot be considered conservation of a natural resource. The use of a more valuable natural resource to recover a less valuable one is not in keeping with a philosophy of total resource management.

Amoco Canada wholeheartedly supports the establishment of reasonable and justified regulations for the protection of the environment. Our activities at West Whitecourt, Bigstone and Alberta in general, reflect our sincere desire to continually improve our gas processing operations.

It is recommended that the present regulations governing the ground level concentrations of sulphur dioxide and the levels of sulphur recovery be continued for the West Whitecourt and Bigstone Plants so long as there is no adverse effects on the environment.

II. WEST WHITECOURT PLANT

A. INTRODUCTION

The West Whitecourt operation consists of the simultaneous depletion of several sour gas fields. The dry sour gas from the Beaver Creek, Pine Creek and Pine Northwest fields located near Edson, Alberta is delivered to the West Whitecourt Plant for compression and injection into the Windfall field. The gas from the Windfall field is processed through the West Whitecourt Plant. Attachment No. 1 shows an overall view of these operations.

The project represented a unique scheme to maximize condensate recoveries from the Windfall field and minimize the production of sulphur during the early project life.

It should be noted that Hudson's Bay Oil and Gas and Canadian Petrofina operate the field facilities and Amoco Canada operates the gas plant. The sulphur plant is owned by Texas Gulf Sulphur but is operated by Amoco. This portion of the brief, therefore, is directed particularly to the operation of the West Whitecourt gas plant.

B. PLANT PROCESS DESCRIPTION

From a maximum Windfall field production of 245 MMCFD the plant is capable of producing 150 MMCFD of sales gas, 7500 BPD of condensate and 1800 LTD of sulphur. 100 MMCFD of Pine Creek gas is injected into the Windfall reservoir.

Attachment No. 2 is a simplified process diagram. When sour gas first enters the plant, free water and hydrocarbon liquids are separated in the inlet separator. The water is routed to a closed disposal system, while the hydrocarbon liquids are processed in the condensate stabilization system. Acid gas (hydrogen sulphide and carbon dioxide), water and hydrocarbon liquids are removed from inlet separator gas to make sales gas. The Acid gas removed in the gas sweetening facility is piped to the sulphur plant for sulphur recovery. Unrecovered sulphur is emitted to the atmosphere in the form of sulphur dioxide.

C. EFFLUENT CONTROL

1. Sulphur Stack Emissions

The principal emission at the West Whitecourt Plant is in the form of sulphur dioxide from the 400-foot sulphur stack. At the present time, the maximum permitted emission from the stack is 210 LTD of sulphur dioxide. This approval also requires a minimum recovery of 95% of all the sulphur entering the sulphur plant.

Attachment No. 3 graphically shows the improvement in sulphur recovery efficiencies since 1966. Also included is the daily average sulphur dioxide emission. It should be noted that the ERCB approved recovery levels were not 95% at the time of plant startup. The initial required recovery efficiency was between 92% and 93%. In 1964, the recovery efficiency requirement was increased to 94% and in 1968 the requirement was again amended to 95%. In 1969, a fourth sulphur recovery unit was added to the plant. This unit included a third converter, as compared to two converters in each of the first three units, which improved overall plant recovery efficiency.

2. Flare Stack Emissions

The plant is operated so that a minimum of gas is flared. The ERCB limit for flaring is one-half of one per cent of the total volume of gas delivered to the plant. Two 150-foot stacks are used for flaring. Sales gas is burned with the sour gas flares for adequate dispersion.

Attachment No. 4 is a graphical plot of SO_2 emitted to the atmosphere as a result of plant flaring. Cause of the flaring is attributed to plant operating problems. Any time the plant, or portions of the plant, is shut down or restarted some waste is created which must be flared or reinjected. Modifications made to improve the on-line time of equipment results in a reduction of flaring. One of the significant changes was the modification of the plant compressors in 1968 to permit reinjection of off-spec sales gas or sales gas during periods of zero demand by purchaser. As a result, gas flaring during the subsequent years has been reduced. Other improvements have included physical changes in the plant processes, implementation of improved metallurgy in plant equipment and modified operating and maintenance practices.

A severe operating problem occurred during the winter of 1971-72 due to changing composition and pressure of the Pine Creek gas. As a result of the retrograde property of the gas, hydrocarbon liquid slugs formed in the transmission line. These slugs caused increased plant flaring until modifications could be effected to eliminate the problem.

3. Burn Pit Emissions

The majority of plant waste drains were originally directed to a burn pit. This resulted in occasional hydrocarbon burning at the pit. In 1970 a three-phase separator was installed to interrupt the flow of waste fluids to the pit. This permitted redirection of vapors to the flare stack and reprocessing of recovered hydrocarbon liquids. The water which may contain water soluble chemicals is routed to the storage lagoons for stabilization prior to reinjection. As a result, there is no routine burning of hydrocarbon liquids at the plant.

4. Water Disposal

All the produced and waste water from the plant is injected into the aquifer underlying the Windfall producing formation.

The produced water from the wells and the plant is processed through a three-phase oil skimmer prior to delivery to the injection wells.

The waste water from the plant which is primarily boiler blowdown water, but which also may contain varying amounts of chemicals is pumped from the waste lagoons to the injection system.

D. POLLUTION MONITORING

1. Exposure Cylinders

A network of 28 atmospheric exposure cylinders is located around the plant. Each station consists of two cylinders, one detects the hydrogen sulphide concentration and the other detects the total sulphur compounds. All cylinders are replaced and analyzed once per month. Attachment Nos. 5 and 6 show the locations of these stations.

The contaminant concentrations have been greater during the winter months than during the summer months since dispersion during the winter appears to be less effective due to temperature inversions and lower wind velocities.

2. Continuous Sulphur Dioxide Monitoring

A pollution monitoring trailer is located approximately one mile east of the plant. Pollution monitoring instruments contained in this trailer are a Davis SO_2 monitor, AISI H_2S Spot Analyzer and wind direction and velocity equipment. Attachment No. 7 tabulates the total time sulphur dioxide was detected for several levels of concentration. The frequency and duration of these concentrations of sulphur dioxide has been extremely low. The total time in which readings were greater than 0.3 ppm was 55 hours since 1966 which is approximately 0.1 per cent of the total time. Thirty-six hours of the above 55 hours were recorded during December, 1971 and February, 1972 when we were experiencing the Pine Creek liquid slugging problem.

3. Continuous Hydrogen Sulphide Monitoring

The hydrogen sulphide concentration as recorded by our continuous monitoring instruments has been extremely low and infrequent. As a result, the data are not presented.

4. Continuous Stack Emission Monitor

Sulphur dioxide and hydrogen sulphide ratios in the tail gas are determined by the Tutweiller method (a chemical analysis method). In 1972, a continuous stack emission monitor was installed to monitor the volume of sulphur dioxide emitted to the atmosphere through the incinerator stack. The ratio of hydrogen sulphide to sulphur dioxide is extremely important in obtaining a high level of sulphur recovery. The Tutweiller analysis is conducted on a scheduled basis. However, the continuous stack emission monitor enables the plant operator to detect if the hydrogen sulphide to sulphur dioxide ratio is drifting off the optimum ratio and corrective action can be taken.

5. Stack Surveys

The ERCB requires the operator to run a sulphur stack survey every three months. A stack survey consists of measuring the volume and SO_2 content of the incinerator stack effluent. An additional stack survey is conducted by the ERCB.

During the time the survey is run, we attempt to correlate our pollution monitoring methods and determine the sulphur plant recovery efficiency. The average emissions recorded during the last five stack surveys were well within the levels approved by the ERCB.

6. Sulphur Dustfall Cylinders

At present, there are six sulphur dustfall cylinders located around the sulphur block to monitor the volume of sulphur dusting (see Attachment No. 8). A dusting problem generally occurs during the crushing and loading of sulphur from the block. We are not presently shipping crushed sulphur nor do we expect to in the near future.

7. Water Sampling

Water samples are taken upstream and downstream from Squaw Creek which runs near the plantsite. Analyses confirm that no pollutants are entering the stream as a result of plant activities.

8. Infra-red Aerial Photographic Surveys

In addition to the above required pollution monitoring programs we have conducted studies to determine if our operations have had an effect on the environment. In 1971, an infra-red aerial survey was conducted over a large area around the plant. Infra-red film is sensitive to the presence of chlorophyll in living plants and stress to the plants can be detected before it reaches a level dangerous to plant life. The stress may be due to natural causes, such as poor drainage, high soil alkalinity, poor soil cultivation techniques, insects, plant disease, etc., or from man-made intrusions such as land clearing or gas plant emissions. The exact cause of the stress can only be determined by field investigations. The first survey was conducted in September 1971, and the survey revealed no vegetation stress due to sulphur dioxide emissions from the West Whitecourt Plant.

The survey was repeated in August 1972 and is not yet compiled. Field investigations in conjunction with these studies detected vegetation stress as a result of sulphur dioxide in poplar and spruce trees on a low ridge to the southeast of the Plant and to Balsam poplar very near the plantsite. The vegetation stress found to the southeast of the plant was mild and of temporary nature. We suspect the cause to be due to gas flaring at the water disposal well in the field. The oil skimmer described previously has eliminated this flaring.

In addition we are members of the Whitecourt Environmental Study Group which was formed in March 1972, to undertake intensive and long-term studies of the affect of sour plant operations in the Whitecourt Area on the environment.

E. TAIL GAS CLEANUP

The ERCB Information Letter IL 71-29 indicated that increased sulphur recovery efficiencies would be required. The Board issued the Letter, having "considered the matter of appropriate sulphur conservation requirements on the basis of current technology and the economics of sulphur recovery and, bearing in mind its responsibilities respecting pollution control." For the West Whitecourt Plant, the sulphur recovery would have to be increased from the current operating level of 95-96% to the minimum ERCB requirement of 98.3%. Texas Gulf Sulphur solicited bids to install tail gas cleanup facilities from three general contractors. Their specification requested a minimum guarantee of 99% to ensure meeting the 98.3% requirement since these processes are not proven. One contractor could not meet this guarantee. The cost of either of the other cleanup processes would be approximately $7,000,000.

The resources consumed for steam and electric power for the cleanup process are valued at $200,000 per year. The incremental sulphur recovered by the cleanup process would be about 50 long tons per day having a value of about $40,000 per year. Since the sulphur recovered does not equal the value of the energy consumed, there is no real recovery of the investment to be made.

Since the evidence of environmental effect after ten years of operation has been minimal and transitory and since we have committed to intensive and long-term monitoring of the environment, there is no justification for the implementation of tail gas cleanup at this time.

III. BIGSTONE PLANT

A. INTRODUCTION

The Bigstone Plant is located approximately 20 miles south of the town of Fox Creek and was placed on steam in July, 1968. Attachment No. 9 is a map showing production and injection wells, gas gathering and injection lines and the plant location. The capacity of the plant is 56 MMCFD of raw gas, 43.6 MMCFD of sales gas and 394 LTD of sulphur. All the gas processed is from the D-3A formation of the Bigstone field, and is dry (contains no liquid hydrocarbons) with only sales gas and sulphur being recovered. The plant is owned by Amoco Canada Petroleum Company Ltd., Atlantic Richfield Canada Ltd., Hudson's Bay Oil and Gas Company Ltd., Marathon Oil Company, and Petrofina Canada Limited. Amoco Canada operates the plant and the field on behalf of the owners.

B. PLANT PROCESS DESCRIPTION

The plant is a typical gas sweetening, sulphur recovery plant. Attachment No. 10 is a simplified flow diagram of the process. Any free water entrained in the raw gas is removed in the inlet separator and injected into a waste water disposal well. The acid gas (hydrogen sulphide and carbon dioxide), water vapors and any hydrocarbon liquids are removed from the raw gas stream to make sales gas. Any excess residue gas above that nominated by the gas purchaser is injected back into the D-3A formation. The acid gas removed from the raw gas stream is piped to the sulphur plant for elemental sulphur recovery. Unrecovered sulphur is emitted to the atmosphere as sulphur dioxide.

C. EFFLUENT CONTROL

1. Sulphur Stack Emissions

ERCB Approval for the Bigstone Gas Plant allows the emission of 33.2 long tons per day of sulphur dioxide (16.6 long tons per day equivalent sulphur) from the 300-foot stack at 1000°F. Present requirements are 95% recovery of all sulphur entering the plant. Attachment No. 11 represents the sulphur recovery efficiencies and sulphur stack sulphur dioxide emissions since startup. Since startup the Plant has operated at an efficiency well above the approved recovery level of 95%.

2. Flare Stack Emissions

At times it is necessary to flare gas through one of the 150-foot flare stacks. When flaring sour gas, sales gas is added to ensure proper dispersion. The sulphur dioxide emitted to the atmosphere at Bigstone has been minimal as shown on Attachment No. 12. The plant has compressors capable of reinjecting off-spec sales gas or sales gas during periods of nil demand to minimize flaring.

3. Water Disposal

All produced water from the gas stream is stored, filtered, treated and pumped into an injection well. Other plant waste water, such as boiler blowdown, is directed to a storage lagoon to allow stabilization and the settling of solids. The water is then pumped from the lagoon, filtered, treated and injected into the same injection well. The level of the lagoon is carefully controlled to prevent overflow.

4. Well Flaring

All wells are equipped with high and low pressure safety shutdown valves. These were installed to prevent a possible uncontrolled emission from the wells. In addition, the gas gathering system is designed to contain the full wellhead shut-in pressure.

The gas gathering system is externally coated and cathodically protected to prevent a pipeline failure from external corrosion. We have a corrosion monitoring and inhibition program to internally protect the pipe. Our corrosion monitoring program has indicated negligible corrosion rates.

D. POLLUTION MONITORING

1. Tail Gas Chromatagraph

In mid-1971, a gas chromatagraph was installed in the sulphur plant to analyze the tail gas stream for hydrogen sulphide and sulphur dioxide. The instrument enables the plant operator to maintain proper hydrogen sulphide to sulphur dioxide ratios and achieve maximum sulphur recovery.

2. Continuous Stack Emissions Monitor

   In early 1972, a continuous stack emission monitor was installed. This monitor measures the volume of sulphur dioxide emitted to the atmosphere through the incinerator stack.

3. Exposure Cylinders

   There are six atmospheric exposure cylinders located around the plant. Attachment No. 13 shows the locations of these stations. A decreasing trend in total sulphation has been observed since plant startup. This trend may be due to the improvement in the sulphur recovery efficiency.

4. Sulphur Dustfall Cylinders

   At present, there are four sulphur dustfall cylinders installed around the sulphur block area to monitor the degree of sulphur dusting. The location of these cylinders is shown on Attachment No. 13. At the Bigstone Plant, sulphur is sold only in the liquid form. Based on the current sulphur market, sale of solid sulphur from the Bigstone Plant is unlikely.

5. Monitoring of Sulphur Dioxide and Hydrogen Sulphide

   We continuously monitor the atmosphere for sulphur dioxide, hydrogen sulphide, wind direction and wind speed for one month during both the winter and summer seasons of each year. No significant occurrence of sulphur dioxide or hydrogen sulphide has been detected.

6. Stack Surveys

Every three months, we conduct an incinerator stack survey. An independent laboratory is contracted to perform this service. The last two surveys indicated average emissions of 11.25 long tons per day and 12.89 long tons per day of sulphur. These rates correspond to 96.7% and 96.5% of sulphur recovery efficiency, respectively, and indicate that we are well within our approval limits. During the stack survey, we attempt to correlate our pollution monitoring methods.

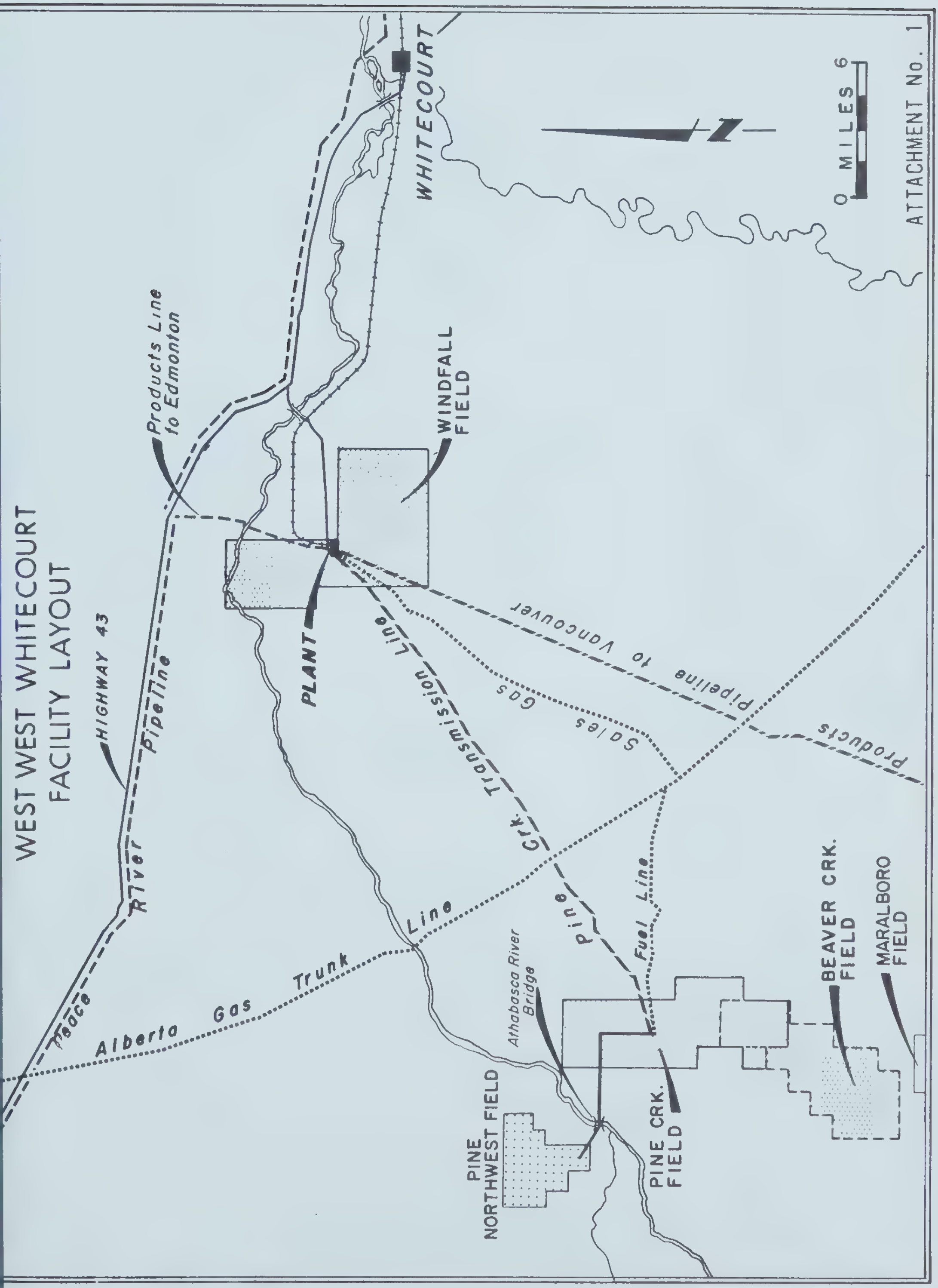
7. Water Sampling

The streams near the Plant are sampled for plant contaminants annually. Analyses indicate no harmful effects on the streams.

8. Infra-red Aerial Photographic Survey

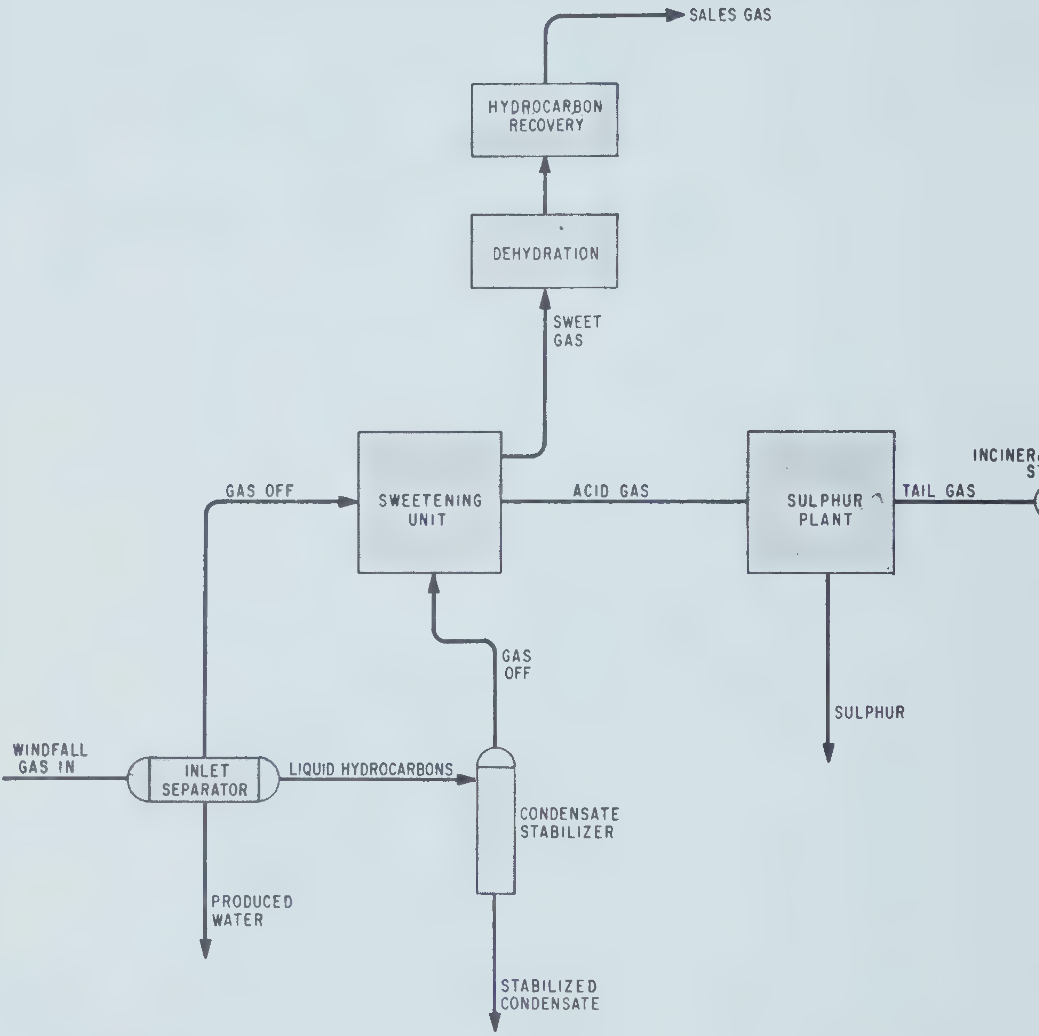
During the summer of 1972, an infra-red aerial photographic survey was conducted over the Bigstone Plant area. The report has not yet been compiled, however, initial inspection of the data indicates there is no evidence of environmental effect as a result of pollutant emissions from the Bigstone Plant.

The Bigstone Plant is a member of the Whitecourt Environmental Study Group.



WEST WEST WHITECOURT FACILITY LAYOUT

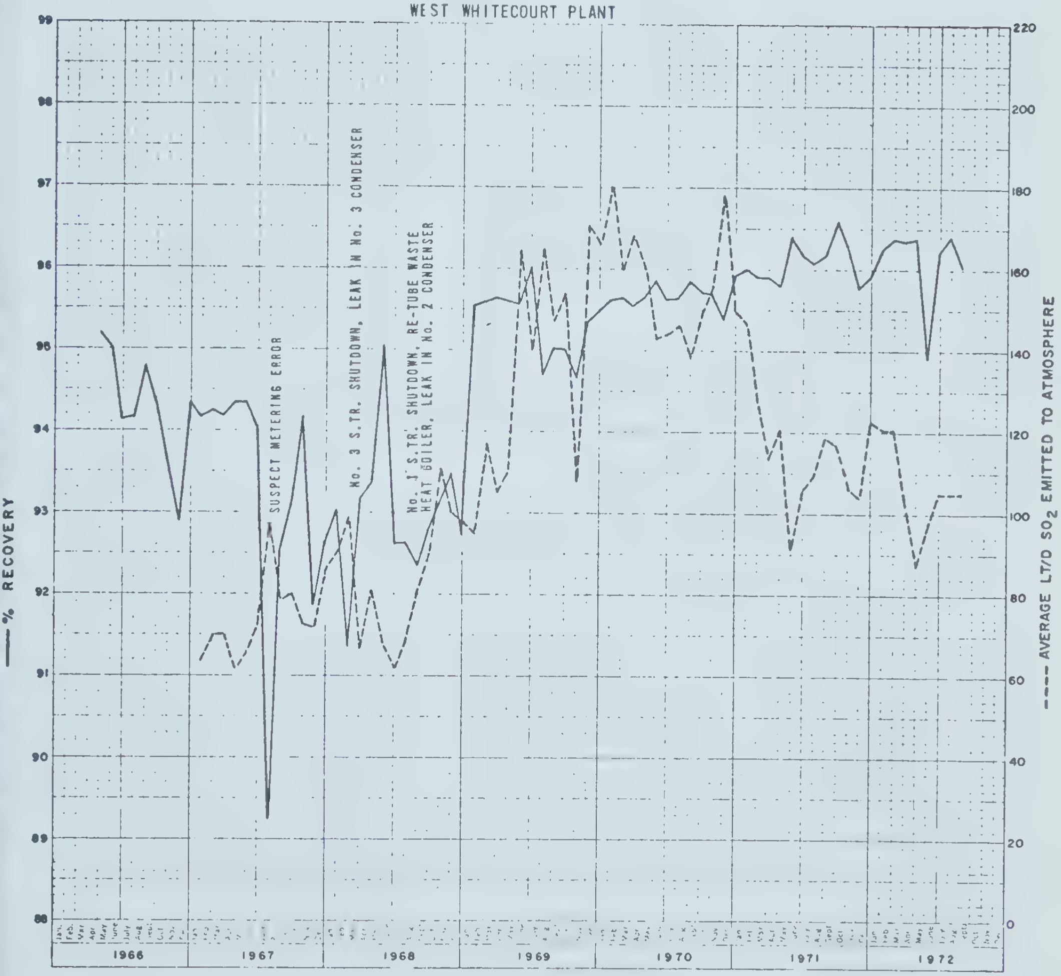
ATTACHMENT No. 1



WEST WHITECOURT PLANT
SIMPLIFIED FLOW DIAGRAM

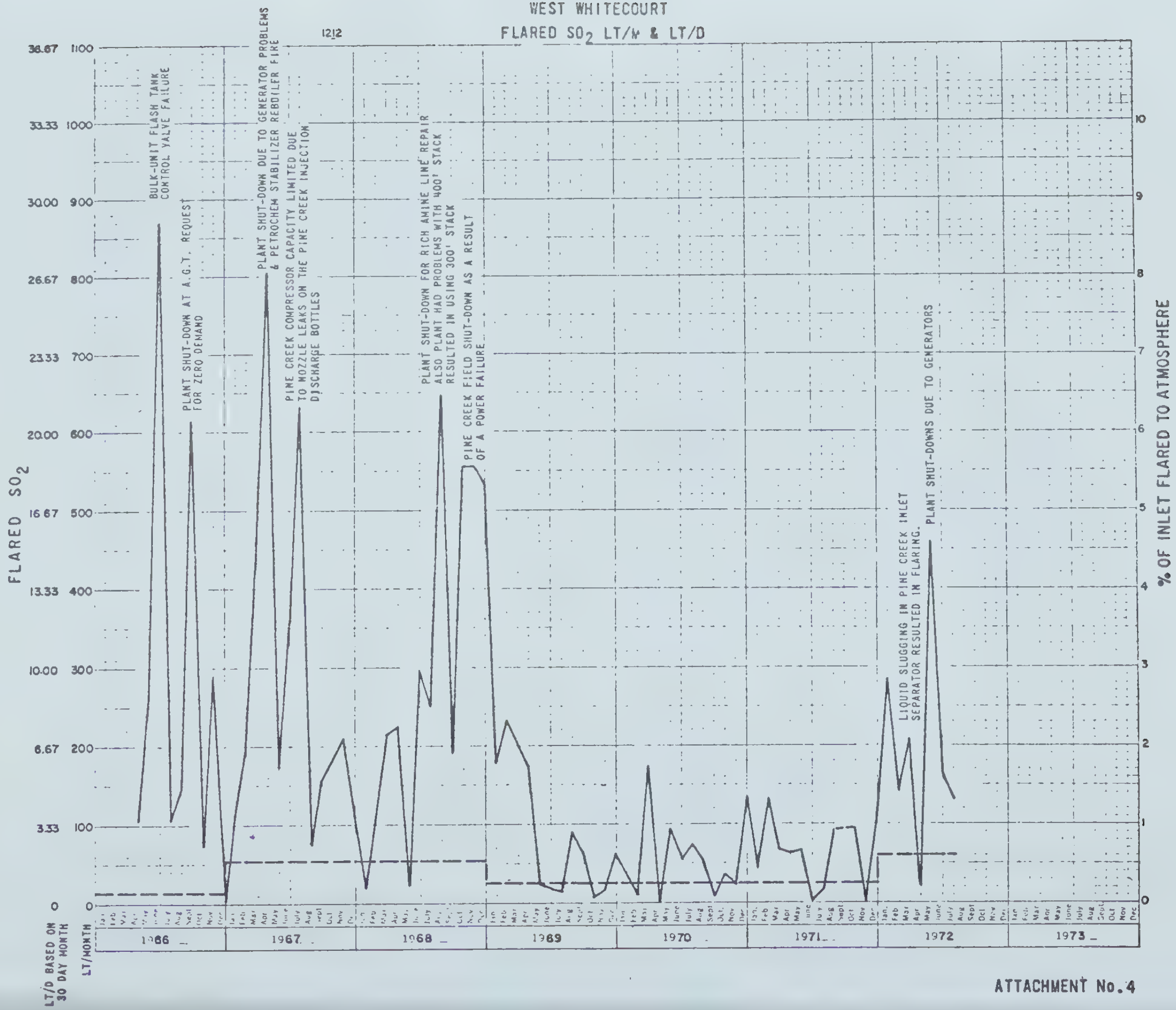
ATTACHMENT No.

SULPHUR RECOVERY EFFICIENCIES
WEST WHITECOURT PLANT

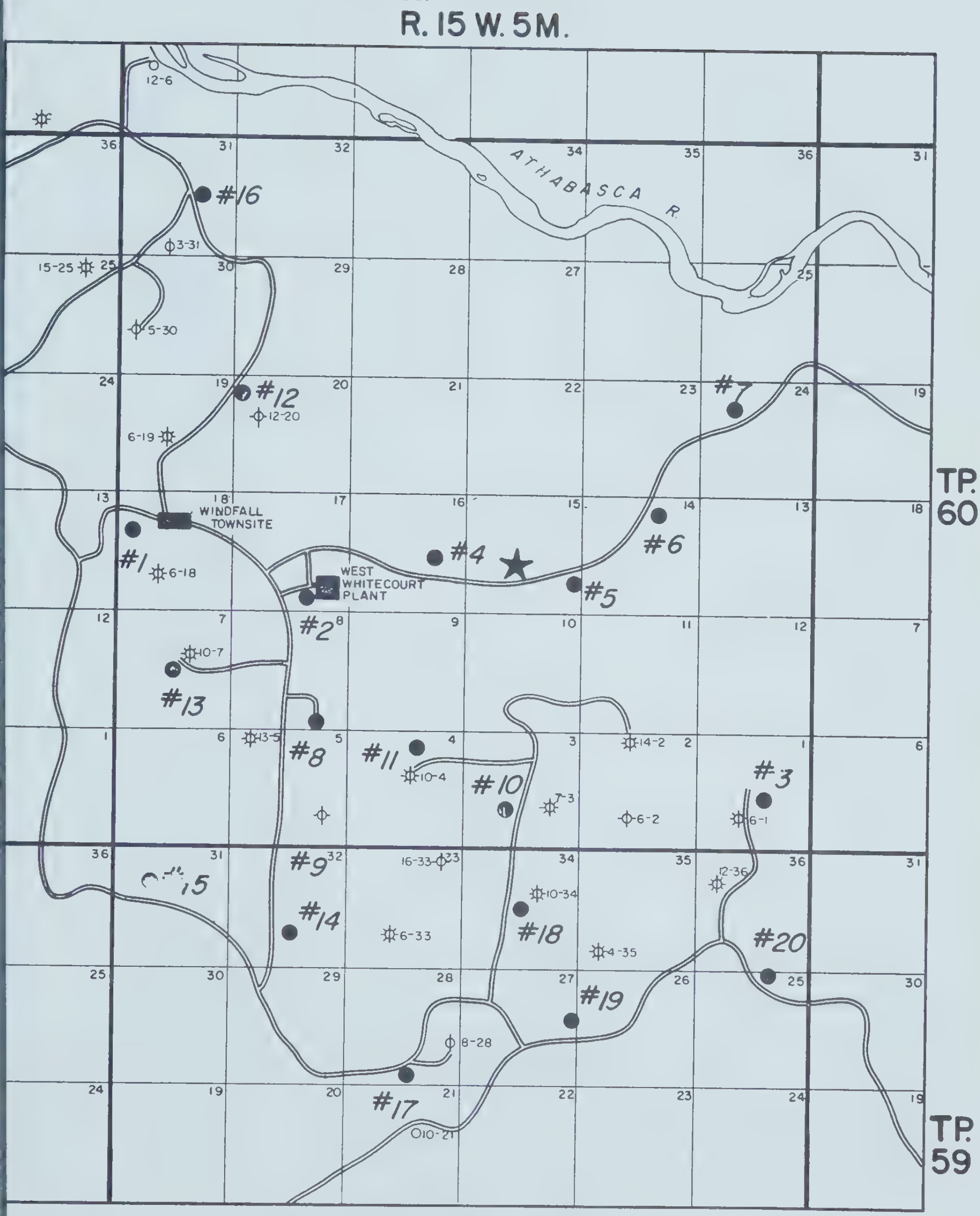


ATTACHMENT No. 3

WEST WHITECOURT
FLARED SO_2 LT/M & LT/D



ATTACHMENT No. 4



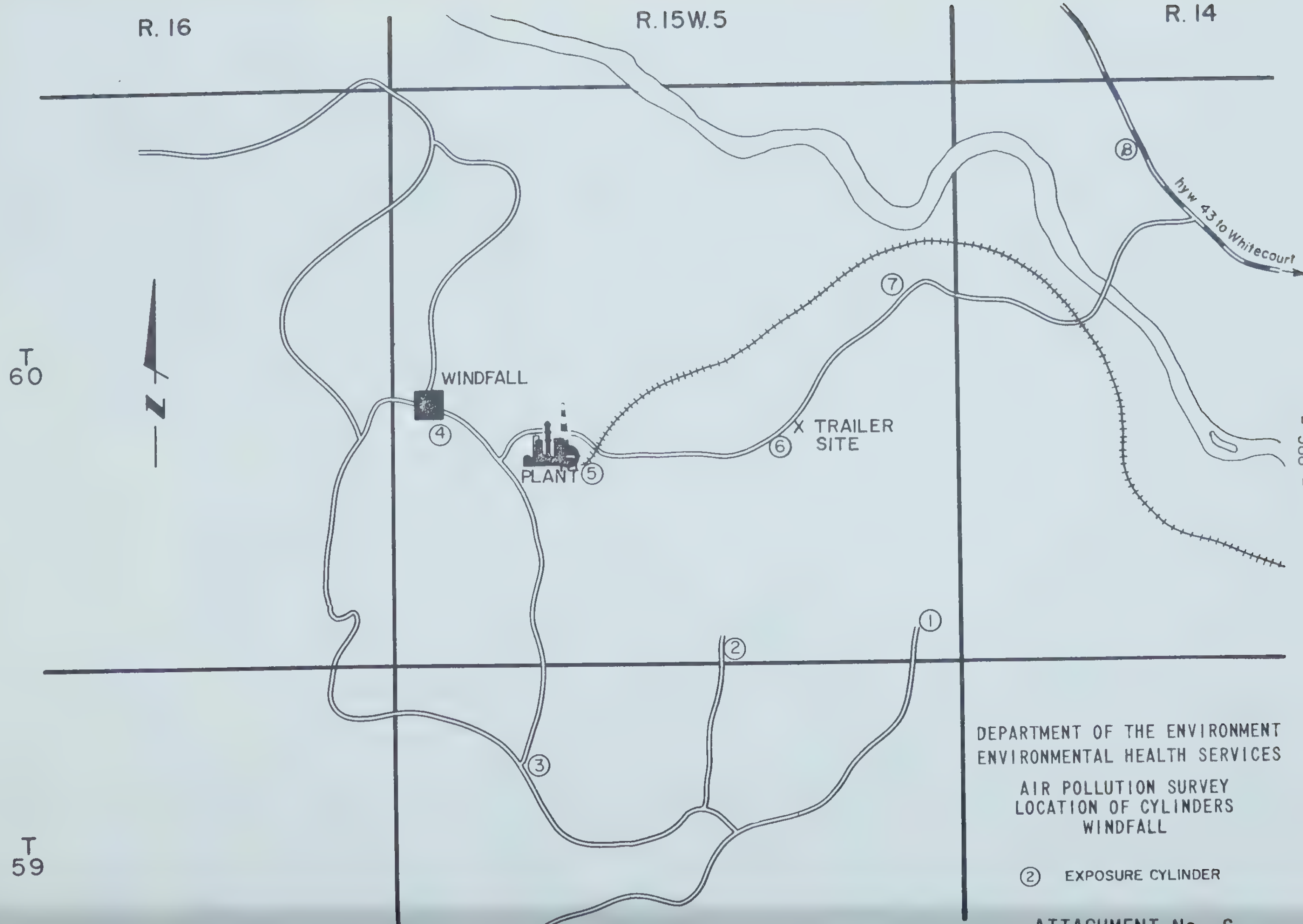
– *LOCATION* –

◐ POLLUTION CYLINDER

★ CONTINUOUS MONITOR LOCATION

WEST WHITECOURT
LOCATION OF ATMOSPHERIC
EXPOSURE CYLINDERS

ATTACHMENT No. 5



DEPARTMENT OF THE ENVIRONMENT
ENVIRONMENTAL HEALTH SERVICES

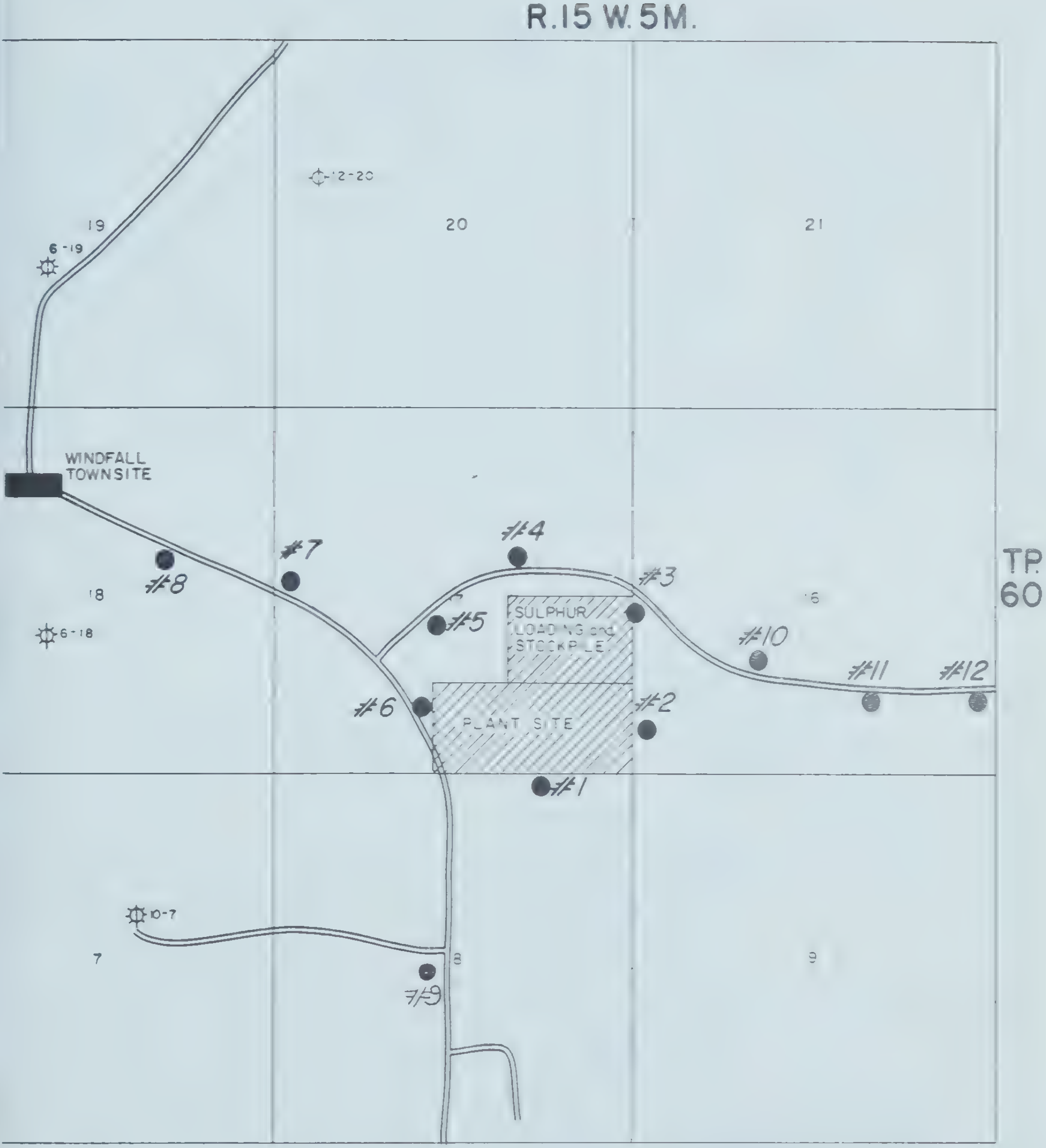
AIR POLLUTION SURVEY
LOCATION OF CYLINDERS
WINDFALL

② EXPOSURE CYLINDER

Attachment No. 7
West Whitecourt
SO_2 Concentration by Minutes

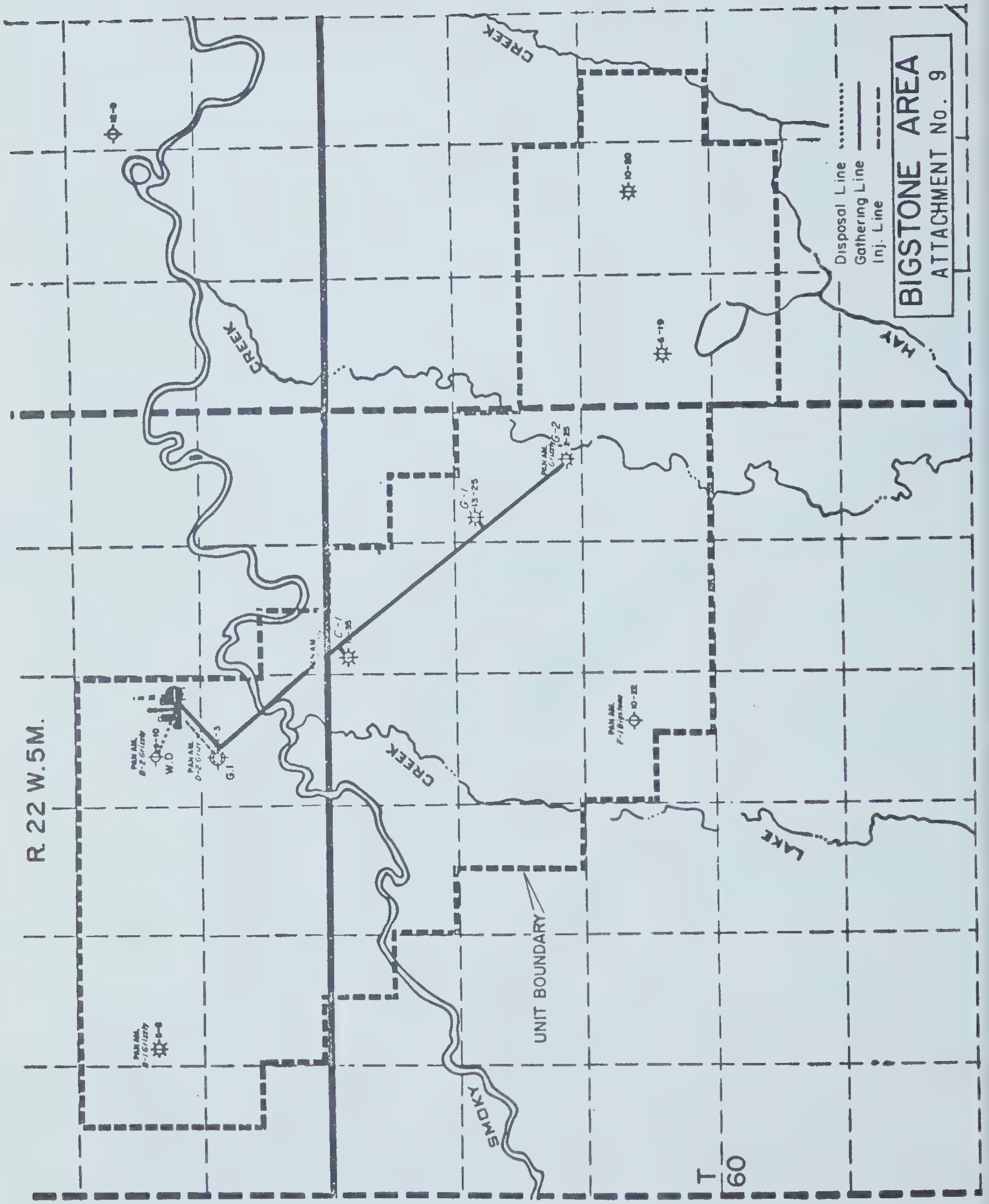
Year	Month	>0-.1 Minutes	.11-.30 Minutes	.31-.50 Minutes	.51-.7 Minutes
1972	June	6407	125	42	2
	May	5092	783		
	April	3155	254		
	March	11925	945		
	February	2671	1235	1050	
	January	4134	3480		
1971	December	3467		648	479
	November	2964	80		
	October	792	180		
	September	1736			
	August	2000	95		
	July	3163			
	June	3261	313		
	May	2843	465	750	
	April	1144	210		
	March	951	101		
	February	1322			
	January	1628			
1970	December	784		115	
	November	278			
	October	79			
	September	328			
	August	577	55		
	July	391			
	June	492			
	May	1712	680		
	April	1978	803		
	March	1245	482	65	
	February	1625			
	January	517	1497		
1969	December	92		26	
	November	58			
	October	3			
	September	23			
	August				
	July				
	June				
	May	190			
	April				
	March	1352	27		
	February	294	15		
	January	136			

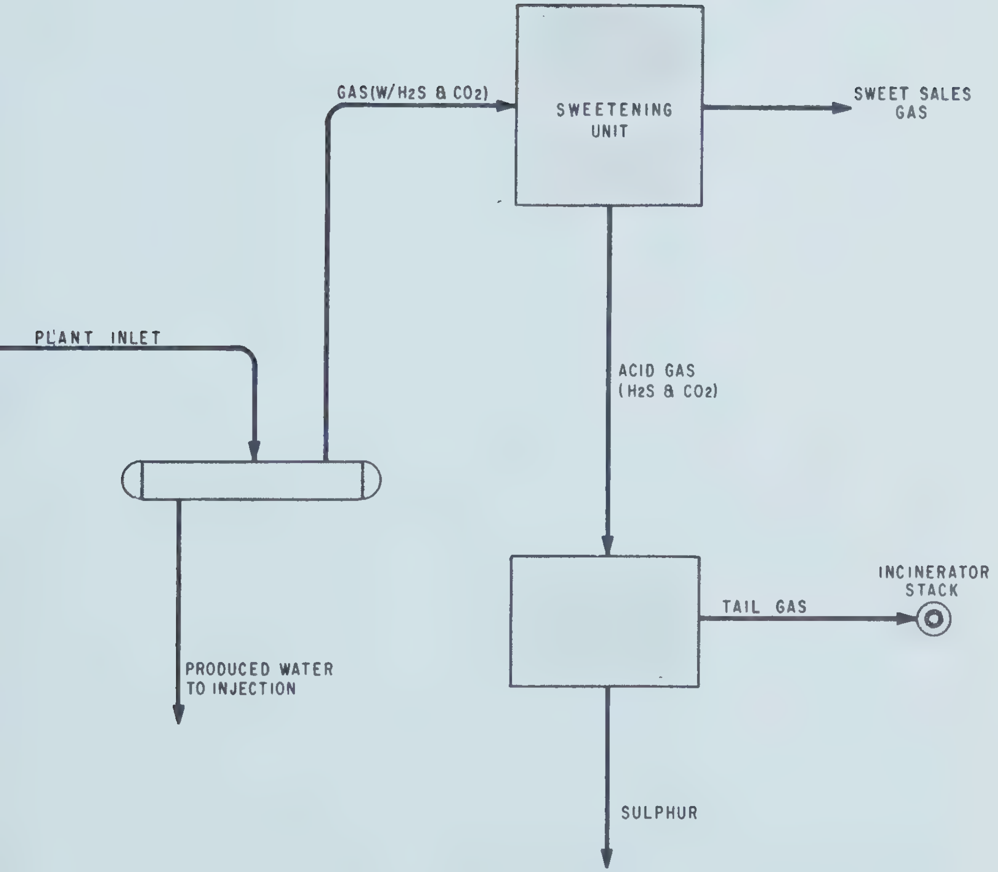
Year	Month	>0-.1 Minutes	.11-.30 Minutes	.31-.50 Minutes	.51-.7 Minutes
1968	December	122			
	November	15			
	October	50	7		
	September	110			
	August	15			
	July	60			
	June	185			
	May	7			
	April	97	6		
	March	36			
	February	213			
	January				
1967	December				
	November				
	October				
	September				
	August	68			
	July	366	96	28	
	June	368	9	72	
	May	277			
	April	399	67	4	
	March	169			
	February	231	10	16	
	January	1563	508		
1966	December	612	150	24	
	November				
	October				
	September	35			
	August	51	3		
	July	31	11		
	June	101	2		
	May	65			
	April	1108			
	March				
	February				
	January				



WEST WHITECOURT
GAS PLANT AREA
SULPHUR DUSTFALL
CYLINDER LOCATIONS

ATTACHMENT No. 8

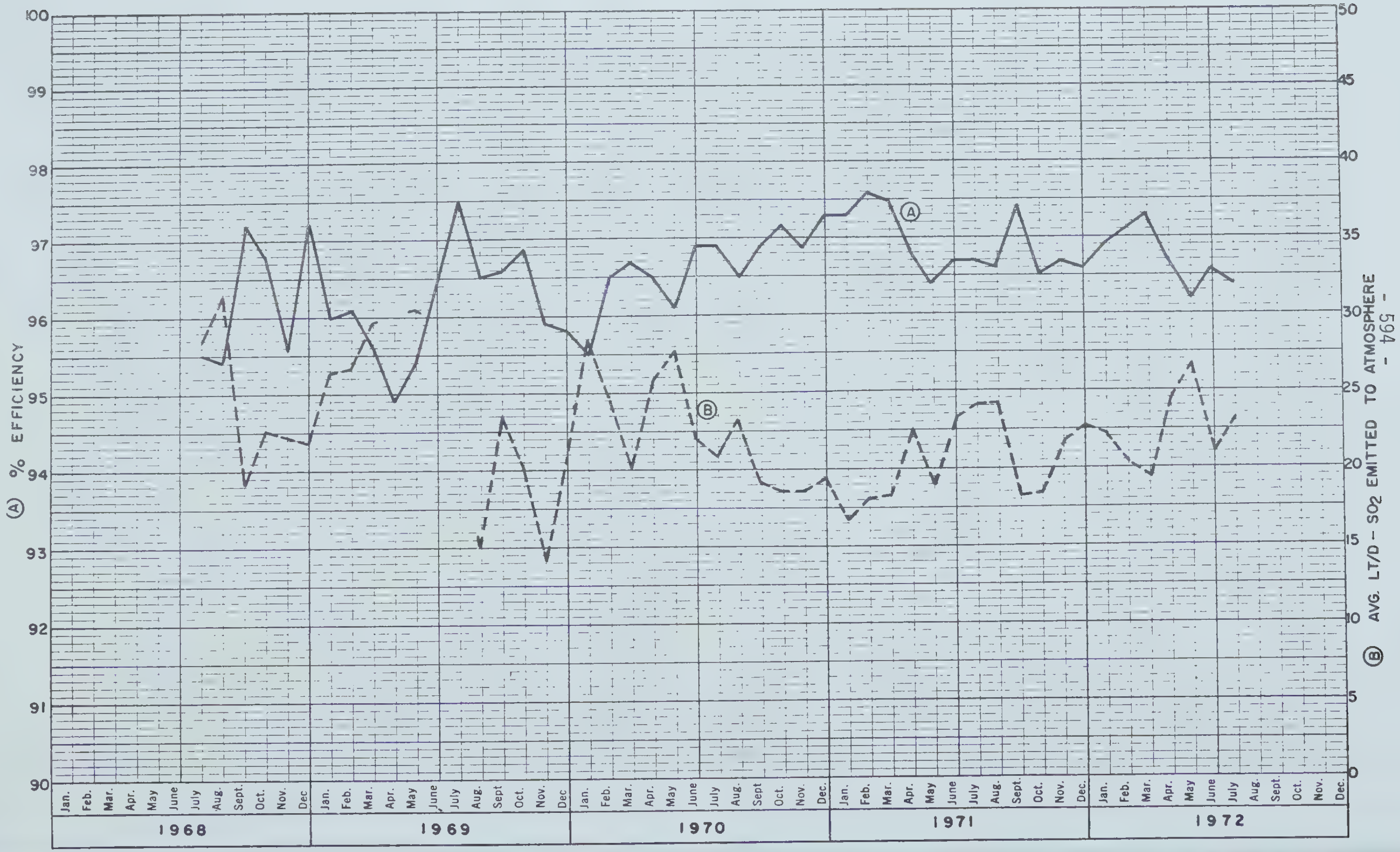

BIGSTONE AREA
ATTACHMENT No. 9
Disposal Line
Gathering Line
Inj. Line
R. 22 W.5M.
T 60
UNIT BOUNDARY
SMOKY
CREEK
CREEK
CREEK
HAY
LAKE
PAN AM. 0-2 Grizzly
W.D
PAN AM. 0-2 Grizzly
G.1
C-1
G-1
13-25
PAN AM. Grizzly G-2
PAN AM. F-1 Bigstone
10-22
10-20
6-19
PAN AM. B-1 Grizzly



BIGSTONE PLANT
SIMPLIFIED FLOW DIAGRAM

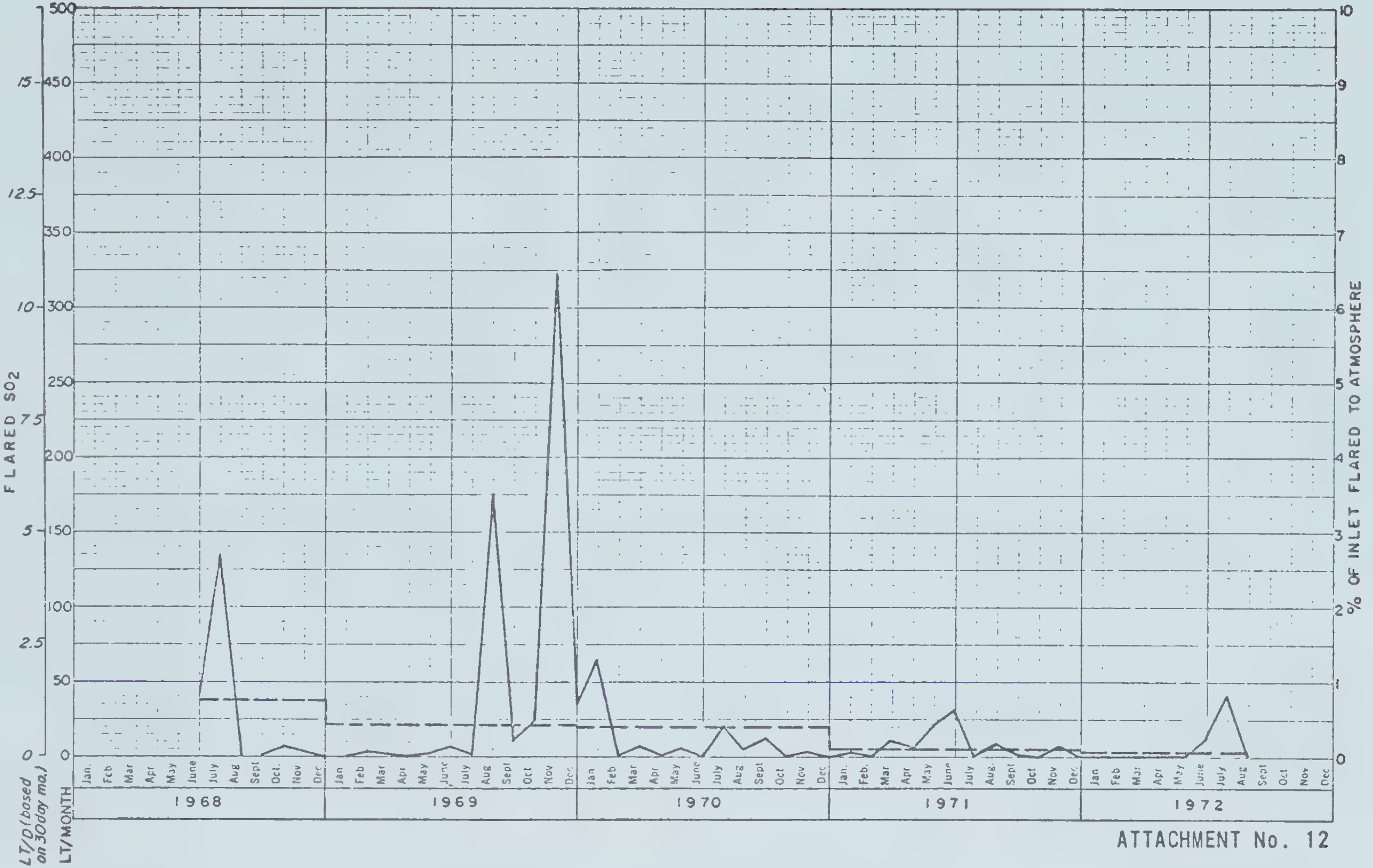
ATTACHMENT No. 10

AMOCO CANADA PETROLEUM CO. LTD.
SULPHUR RECOVERY EFFICIENCIES
BIGSTONE PLANT

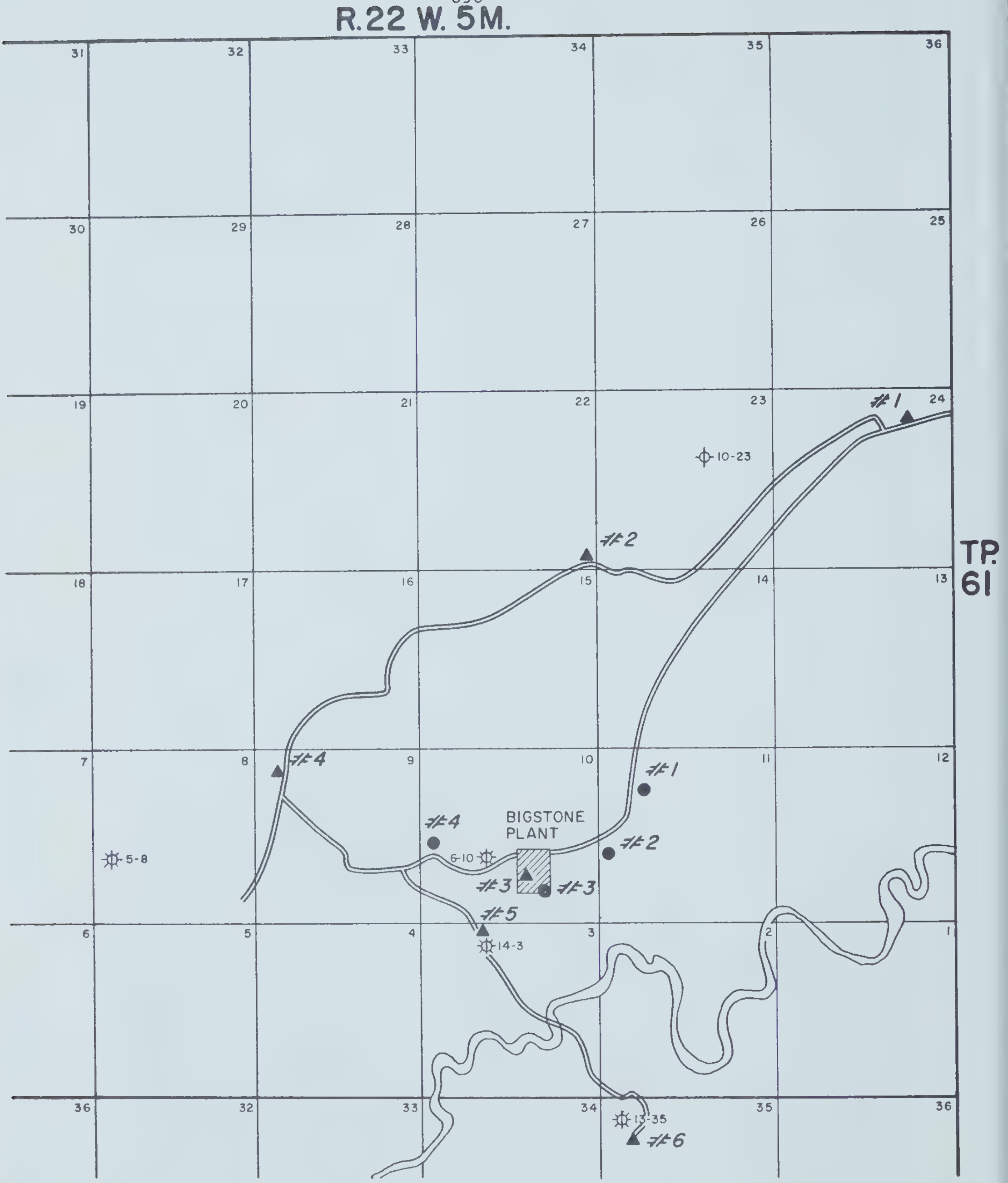


ATTACHMENT No. 11

FLARED SO_2 — BIGSTONE



ATTACHMENT No. 12



— LEGEND —

● DUSTFALL CYLINDER

▲ EXPOSURE CYLINDER

BIGSTONE
GAS PLANT AREA
SULPHUR DUSTFALL &
EXPOSURE CYLINDER
LOCATIONS

ATTACHMENT No.13

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

I'm interested in your statement, if I understood you right, that the conservation of a wasting resource is not justified under any circumstance. Would you care to comment on whether it is possible we may run out of elemental sulphur or the means of acquiring it within the next twenty or thirty years, when our gas is gone?

MR. A. NEIDERMAYER

I don't know that I can foresee that far; there certainly is currently a glut of sulphur on the market. Forecasts that I've seen indicate the continuance of this situation over certainly the next ten to fifteen years. Now of course, prognosticators are continually proven wrong, but beyond the ten or fifteen years I really can't comment on the depleting resource. I guess all resources are depleting and eventually we might run out.

DR. S.B. SMITH

Do you think that a ten- or fifteen-year planning period for depleting resources is an adequate planning period?

MR. A. NEIDERMAYER

Well, conceptually, the projects that we have implemented in this business are normally for a twenty-five year project life. We enter these projects with the idea of returning our investment and making a profit over that length of time. We are ten years into this project and we see another fifteen years to fulfillment.

DR. S.B. SMITH

Let's put it another way. Let's say there isn't a nickel in sulphur, that it's worth nothing, but that the Energy Resources Board or the Department of the Environment, either of Alberta or Canada, has said that you can't put sulphur in the form of sulphur dioxide into the landscape. Could you still operate your gas plant at a profit?

MR. A. NEIDERMAYER

I'm going to have to take you back a little bit here. You want to remember that I represent a portion of the ownership out there. We are the operators of the entire facility. Amoco, Hudson's Bay and Petrofina own the gas, and we sell the acid gas for the manufacture of sulphur to Texas Gulf Sulphur. I think that we have demonstrated that there is an enormous investment burden here, as well as quite a high operating burden to recover a fairly small amount of sulphur -- fifty tons per day. I will repeat that the cost in energy to recover the sulphur is far in excess of the value of the sulphur; my numbers indicate a factor of about five to one. So, if we're concerned about depleting resources, well I have to consider the resource that I have to consume to recover the sulphur as well.

DR. S.B. SMITH

That's making the assumption that the dispersion of the gas, the methods of dispersion, the places it goes, and the uses to which it is put won't change. That is, we're shipping raw gas down a pipeline and that's a basis on which you are arguing the point?

MR. A. NEIDERMAYER

Well, of course, we do meet a certain commitment. If we did not consume this gas we would not produce it today, but somewhere down the road. So there would be a deferral by the amount of gas consumed to recover the fifty tons of sulphur.

DR. S.B. SMITH

Why do you destroy your records after a certain number of years?

MR. A. NEIDERMAYER

It's just a practice; you accumulate so much paper over a number of years that at some point in time you decide continued storage of these data is no longer required, so you ship them out to the paper mill.

DR. S.B. SMITH

You wouldn't think it justified that these data may be important on microfilm? You can get thousands of pieces of data on little pieces that big?

MR. A. NEIDERMAYER

We haven't felt this. I know gas charts and many other forms of data from the plant are destroyed after a certain period of time, some of them sooner than others. I feel like these data may be available someplace, but they weren't available at the source where we attempted to acquire them.

DR. S.B. SMITH

Have you any idea how much it costs to recover a ton of sulphur?

MR. A. NEIDERMAYER

Well, again, if it's that last fifty tons of sulphur that we are going to recover, it's very expensive.

DR. S.B. SMITH

No, let's forget about the increment. Let's talk about the sulphur that's being recovered now, the 95 percent or so.

MR. A. NEIDERMAYER

The total 95 percent -- again at this particular plant I'm afraid I'm not in a position to speak about it because we deliver acid gas to Texas Gulf Sulphur. It's their investment in the facilities; we operate it on their behalf, they pay the bills for the operation of this plant.

DR. S.B. SMITH

You have no idea what it costs?

MR. A. NEIDERMAYER

Well, let me relate a couple of numbers that come off the top. Operating costs associated with recovery -- just strictly operating costs, not the return on the investment and depreciation and so on -- are somewhere in the order of $1 per ton. But they've got several millions of dollars invested out there for which they hope to recoup their investments, so when we add that to the operating cost I really can't answer it.

MR. W.A. FLOOK

Mr. Neidermayer, you indicate that you inject produced water into an aquifer underlying the Windfall formation.

MR. A. NEIDERMAYER

That's correct.

MR. W.A. FLOOK

Is there any reason why you don't inject it right into the producing formation?

MR. A. NEIDERMAYER

Well, in fact, it is the producing formation. You appreciate that the hydrocarbon in this reservoir exists on the top and underlying that is an aquifer, an enormous aquifer. We don't want to foul up the production of hydrocarbons, so we put the water into the aquifer.

MR. W.A. FLOOK

It's not a separate formation?

MR. A. NEIDERMAYER

No, it's part of the same formation.

MR. W.A. FLOOK

What do you think happens to this eventually, this produced water? In this case, since it's in the same formation, it serves to exploit the formation a little further, doesn't it?

MR. A. NEIDERMAYER

There's an incremental satisfaction, but very, very nominal compared to the withdrawals and the amount of water we're putting in. I might reiterate that there are two sources of water here. There is water from the wells produced as a result of processing fluids that we returned to the formation, plus the water that we run through our boilers, and other waters in the plant that we also accumulate and re-inject into the formation.

MR. W.A. FLOOK

More water goes in than came out?

MR. A. NEIDERMAYER

That's right.

MR. W.A. FLOOK

And it's different?

MR. A. NEIDERMAYER

It's different.

MR. W.A. FLOOK

You described your monitoring systems, your control systems, and you showed pictures of your trailer with monitoring instruments for air quality. Do you in fact have any methods of checking those instruments? How often do they get checked, and by what devices?

MR. A. NEIDERMAYER

Well, there's a series of checks that are conducted. Number one, we have a plant lab technician at the plant who daily goes out and checks the instruments -- that is, the normal working day, five days a week. Beyond that we do periodically calibrate this equipment, I believe from an outside source, and I'm relating now to our practices in another plant. I'm not specifically familiar with what we do here, but there is,I believe, a further calibration done by an outside party.

MR. W.A. FLOOK

What about the continuous monitors on your stack gases?

MR. A. NEIDERMAYER

Well, a continuous monitor on stack gas is a rental piece of equipment from one of the contractors or consultants in that area, and they maintain this thing. That is checked every three months, when we go out and run these stack gas surveys, so at that point we have a check on the performance of the continuous stack gas monitor.

MR. W.A. FLOOK

In other words these instruments are monitored every three months?

MR. A. NEIDERMAYER

I guess that's right. And again, I'm not sure of the explicit procedures the consultant uses, but the plant people certainly know if an instrument is deviating, and are on a moment's notice call to check the instrument if it's not performing to their satisfaction.

MR. W.A. FLOOK

The only point that I'm trying to make is that you want to be sure, at any given time, if the instrument indicates an abnormal reading, whether the instrument has gone out of kilter, or whether in fact . . .

MR. A. NEIDERMAYER

That's done on site by the operator. Let's say the reading is beginning to go up and he suspects a problem in one of his sulphur units -- and of course we have four out there -- he would proceed to go back and look at the operating variables for the plant. If he saw nothing wrong there in the way of temperatures, he would run a Tutweiler on each train to determine if he is off ratio. Usually by that time he has found out what the problem is.

MR. W.A. FLOOK

I see, he has an alternative chemical method of . . .

MR. A. NEIDERMAYER

Yes, we have an on-site test . . .

MR. W.A. FLOOK

And this is done any time he suspects something might be wrong?

MR. A. NEIDERMAYER

As a matter of fact he does it routinely, twice per shift per train, or every four hours.

DR. W.R. TROST

I'd like to continue some of the questioning that has been begun, but also refer you, Mr. Neidermayer, to the relationships that the companies have to the government agencies in respect to legislation and regulations. Do you find any particular difficulty presented to you by the way the regulations are now formulated and handled?

MR. A. NEIDERMAYER

The current regulations, in our situation, I don't believe are creating a problem. The thing that we are concerned about, and I think one of the reasons that you folks are out here reviewing these problems with us today, is the fact that we have on the horizon some new, potentially more stringent regulations regarding both the calculated quality of the air at ground level, and the recovery efficiencies from the plant. This does concern us and we hopefully have made a demonstration here that there is no need to proceed in that direction. As far as we're concerned, the best monitor that we have out there is the forest itself, and we have made a commitment and have demonstrated a beginning to monitoring the intrusion that this SO_2 is having on that environment.

DR. W.R. TROST

So your basic problem is not the way things are done right now, or how responsibilities are divided or organized among the departments and agencies, but really the new guidelines that are on the horizon?

MR. A. NEIDERMAYER

That is correct.

DR. W.R. TROST

Are you going to appeal them, by the way? Has your company decided yet whether it is going to make a presentation in respect of the unique treatment in . . .

MR. A. NEIDERMAYER

Are you talking about the more stringent recovery and guidelines set by the Conservation Board?

DR. W.R. TROST

Yes.

MR. A. NEIDERMAYER

Yes, we do plan to appeal it. We have had a deferral here for a couple of months. Again I can't speak totally in regard to the problem at this point because we represent a number of owners at the plant, but we do have the sulphur plant, and that's the East Crossfield plant.

DR. W.R. TROST

Right. Now, what is the nature of your feed gas? You have more than one field -- is there a variation in the composition of your field gas?

MR. A. NEIDERMAYER

Oh, most definitely. The Windfall field originally was low in hydrogen sulphide, about 15 percent,and very rich in liquids. When we put this project on stream sulphur was at a low ebb as well, so we decided at that time to take the dry sour gas from the fields to the west that we showed you on the chart, and inject them into this liquid-rich reservoir in an attempt to optimize recovery of these liquids. Now, the Pine Creek gases again vary. The D3, which is one producing horizon over there, had a 26 percent H_2S content, and the D1 field, the one that currently is giving us some problems with regard to liquid slugs, is 35 percent H_2S. So we have attempted to defer the sulphur and optimize the hydrocarbon liquid recovery with this scheme of things.

DR. W.R. TROST

And is that the decision that gave you the trouble with the hydrocarbon equipment?

MR. A. NEIDERMAYER

No, we had a blend of D3 and D1 gases from the fields to the west. The D3 gas was nearing depletion, so we've got a higher volume of the D1 gas, which has got 35 percent H_2S. This change in blend has prompted liquid to form in our transmission line. These liquids are about 75 percent H_2S and during the period of problem we had large slugs, 50 to 100 barrels, rolling into the plant at one time and we were not able to process these liquids in their entirety, so we had to flare some.

DR. W.R. TROST

So you blew it out, and that gave you some of these ups and downs?

MR. A. NEIDERMAYER

Right. That gave us some of the problems there for a couple of months. We're now over that problem and have it resolved. But it was a unique thing that we had not anticipated.

DR. W.R. TROST

Now, on the design of your plant. I've forgotten the dates; did it start roughly ten years ago, or something of that sort?

MR. A. NEIDERMAYER

We started in April of 1962.

DR. W.R. TROST

So it was about ten years ago. Are you still using that same design?

MR. A. NEIDERMAYER

Yes, and with time, what has happened, we have injected the extremely dry sour gas into the Windfall reservoir, but in turn it has broken through to the producing wells, and so we have had a gradual increasing percentage in H_2S content over the years. Initially we had 800 tons of sulphur capacity, then we had to go up to 13, and now we've gone up to 18. So we've had to accommodate with incremental expansions to take care of the increase in acid gas content.

DR. W.R. TROST

Are you still using the same Claus apparatus, the same number of stages?

MR. A. NEIDERMAYER

Yes, the original plants were two-stage units; the third plant was a two-stage unit, and when we put in a fourth plant it was a three-stage unit, and that did help us improve the recovery.

DR. W.R. TROST

One of the companies was using a four-stage Claus, and was getting a substantially higher percentage conversion than you. Is there a reason why a four-stage wouldn't do you a similar benefit?

MR. A. NEIDERMAYER

Well, yes, with each stage there is an increment of recovery, but it's a . . .

DR. W.R. TROST

Diminishing increment.

MR. A. NEIDERMAYER

It certainly is. We can get 95 to 96 percent with two stages. From two stages to three stages we can get another percent to a percent and a half. With a fourth stage we can get maybe a half a percent, so you know it's certainly a diminishing return.

DR. W.R. TROST

Yes. Now what are your emissions under present operations in long tons per day of sulphur?

MR. A. NEIDERMAYER

The chart displayed recently that we've been running about 140 to 150 tons, and again our throughput here in the last year and a half has been somewhat reduced. If we were at full throughput we would be running 180 to 190 tons, which is under the 210-ton limit.

DR. W.R. TROST

So you're recovering how much sulphur, then?

MR. A. NEIDERMAYER

Currently I believe we're running somewhere in the order of 1400 or 1500 tons a day.

DR. W.R. TROST

Are you stockpiling the major part of that?

MR. A. NEIDERMAYER

Some is going to the stockpile, as I understand, and again this is Texas Gulf I'm speaking for now; they even process their own sulphur, but it's either going to the stockpile or being shipped out in liquid form.

DR. W.R. TROST

I see. Since the plant is kind of a group of companies operating it, each company has its share of the sulphur, as it were, and they each handle it individually?

MR. A. NEIDERMAYER

No. We, the original owners, sell the acid to Texas Gulf Sulphur. They process thier acid gas and manufacture sulphur. We operate the plant for them; they handle their own shipping.

DR. W.R. TROST

So the Texas Gulf Sulphur operation isn't on the plant? You send the sulphur to them and let them worry?

MR. A. NEIDERMAYER

Well, I guess that's right. We operate the entire facility, they own the plant, we get return for the acid gas that we deliver to them, and it's in proportion to the amount of money they're getting for the sale of sulphur.

DR. W.R. TROST

Where physically does that sulphur reside -- the sulphur that you extract from your plant? Do you ship it . . .

MR. A. NEIDERMAYER

It either goes onto the block or is shipped out in liquid form, and they are currently shipping most of their sulphur in liquid form.

DR. W.R. TROST

So you know what's happening to the block, which is presumably on the grounds of the plant?

MR. A. NEIDERMAYER

That's right.

DR. W.R. TROST

But as far as you're concerned, the liquid sulphur is removed from the plant and its destination is not part of your information?

MR. A. NEIDERMAYER

That is correct.

DR. W.R. TROST

Well, what part is going forward as liquid, and what part is being stored? Do you know that?

MR. A. NEIDERMAYER

I don't know what that ratio is at this point.

DR. W.R. TROST

Half and half?

MR. A. NEIDERMAYER

I would guess that, possibly higher.

DR. W.R. TROST

We're interested in the economic facts that are involved in this problem, as you are too, of course. Can you tell us in any rough terms what it costs to take the sulphur out of 1000 cubic feet of your feed gas, assuming you don't sell it? Or any other unit?

MR. A. NEIDERMAYER

You want to know how much it costs to sweeten the gas?

DR. W.R. TROST

Yes.

MR. A. NEIDERMAYER

I don't have that number at my fingertips, but if I could relate this mentally to some number that I am aware of, we operate the plant facility out there for somewhere in the order of a couple hundred thousand dollars per month, and we're processing about let's say 200 million per day, so that would be six billion . . . It would be very difficult to break it out because we've got so many other operations in the plant. The sweetening is a portion of it; we've got liquid stabilization.

DR. W.R. TROST

Can we leave the question with you and ask you later in the evening?

MR. A. NEIDERMAYER

Yes, I'll have to try and come up with an answer.

DR. W.R. TROST

Now, you're operating at something above 95 percent recovery currently, and the guideline for your plant would be, if I've got this right, 98.3 percent, is that right?

MR. A. NEIDERMAYER

Right. By interpolation our people say that we have to get to 98.3 percent minimum.

DR. W.R. TROST

So that you'd actually have to shoot for something higher than that on the design?

MR. A. NEIDERMAYER

This is what we feel at this time. The state of the art is not proven. There are a number of plants going in, and we have not seen the results of the performance of these plants, so we feel we've got to,if we are going to attain it, have a margin of kitty there.

DR. W.R. TROST

Right. I know that some of these questions are made more complex by the stockpiling process, but as I said before, in Red Deer the farmers pile their wheat on the field for a while too, and it's therefore just a kind of a temporary complexity. If we're looking at the cost of extracting the sulphur in respect to selling the sulphur, you talk about the incremental cost, and I understand what you mean, but if you were to look at the whole sulphur operation then you would be just calculating how much it costs to get whatever amount of sulphur you had to get out, starting from zero percent up to your final percentage. Now, I know that that is the way the new guidelines have been developed--not on an incremental cost, but on an integrated overall cost. When you do these calculations, as I'm sure you've done, do you get the same difficulty? If you're doing it on an integrated basis, is the cost of getting out the sulphur you're required to get out altogether greater or less than the value of that sulphur? When you do that calculation, as against when it is done separately, do you find that it is a profitable operation in the overall?

MR. A. NEIDERMAYER

I'm really not sure that I understand what you're asking for, but when we talk about incremental sulphur, I think it's a very valid comparison because we are only currently selling 60 percent of our sulphur out of Alberta. Your questions earlier about how much we were moving out of Whitecourt really aren't relevant because, you know, people work deals -- they might ship their sulphur out of one that is close to the rails, say down in the Calgary area, so the incremental sulphur really goes on the block. It's not sold, because we're currently not selling what we're making, but if you're asking how much I would have to get per long ton of sulphur when I include the additional investment to make this thing economically attractive, I have to get a lot more than the current $6 or $5 or $4 a ton that the marketers are getting. Again, I can't speak for this plant, but I think I can relate to our East Crossfield operation, where we do have an integrated system; some quick numbers we've run there indicate that we would have to get $13 per ton for all of the sulphur that we would sell. And that's assuming the 60 percent level, to make the investment of tail gas cleanup very economic.

DR. W.R. TROST

On an incremental basis?

MR. A. NEIDERMAYER

No, not on an incremental basis.

DR. W.R. TROST

On an integrated basis?

MR. A. NEIDERMAYER

We're selling 60 percent of the total sulphur, and that includes a small increment that we got as a result of the tail gas cleanup, so we throw in the new investment for tail gas cleanup and we say we have to get $13 a ton to get about an 8 percent return on our investment, our total investment.

DR. W.R. TROST

Yes. As you know, the calculation is very simple. If an old plant has two Claus units or three, then the cost to add a fourth as compared with the extra recovery is one calculation, but if you're building a new plant with four units, then the costs of those four units built at that time as compared with all of the sulphur you are recovering, those are the two calculations that one is interested in,right?

MR. A. NEIDERMAYER

I don't believe so. I think if you were building a new plant you'd probably go to two Claus and put in a tail gas cleanup.

DR. W.R. TROST

Well, whatever it might be, whatever the combination might be.

MR. A. NEIDERMAYER

Right.

DR. W.R. TROST

And we've had the submissions now repeatedly on the tail gas cleanup operation with certain costs, and I'm trying to get it from you rather than from the person who is talking about the tail gas cleanup, and I'm having trouble.

MR. A. NEIDERMAYER

Well, I wish I could help you, Dr. Trost, but I'm really not sure I know what you're getting at. You don't want incremental, you want the total project cost. You want my depreciated investment originally plus the new investment now, and you want me to tell you how much I need to sell my sulphur for, to still make it profitable.

DR. W.R. TROST

Right. I know full well that you've already done the calculation.

MR. A. NEIDERMAYER

Well, I have to relate to the $13 a ton, and this is based on a calculation done for Crossfield. To get an 8 percent return on that total investment you have to sell it for that amount. That's selling 60 percent of it. We're still in this competitive area of only selling a portion of our sulphur.

DR. W.R. TROST

Do you mean then that if you were selling 100 percent of it, the necessary cost would be reduced by that proportion?

MR. A. NEIDERMAYER

That's right, yes.

DR. W.R. TROST

So that you'd almost make it go at seven bucks?

MR. A. NEIDERMAYER

Eight! And again these are pretty quick numbers that I'm giving, so I wouldn't want to be......

DR. W.R. TROST

And we know these things change, even when we're talking, you know. We're very interested, as I know you are, in the economic side of things and I appreciate the difficulties that there are in answering these questions which relate to a part of an overall process. I'm thankful that you were able to help us the way that you have done, but now let's return to another question that has been significant here. I think you have put the case for the unique nature of different plants implicitly, if not explicitly. Are there unique problems or unique situations that are relevant to your plant that mark it off from others, or do you feel it to be one of the kind of which there are several members?

MR. A. NEIDERMAYER

I think it would be difficult to wrap them all up in one ball. I mean, our prime interest is the intrusion that these operations are having on the environment. We've heard today that certain locations have a more severe bearing on operations than others. I'm not going to say that we are in a better meteorological position than other plants, but I suspect that maybe we are. The reason I say that is that we've been there for ten years, we've had the emissions ongoing that we've discussed, and we're now currently being asked to reduce and we have not seen that adverse effect on the environment. Now to me that's the living truth, and maybe we admit we don't know all about the effect we've had on the environment, but we've only got another fifteen years to go, and somebody mentioned this morning that that force has been there for tens of thousands of years, so I don't think this intrusion for that short period of time under the current operating practices is going to be detrimental. We hope to prove that with the efforts we are currently undertaking.

DR. W.R. TROST

And you are a participating member of that research group that made that presentation earlier?

MR. A. NEIDERMAYER

Very much so.

DR. W.R. TROST

One final question. Stack control, that's control based on SO_2 levels in the stack as against ambient ground level control, ambient air quality control -- do you favor one or the other?

MR. A. NEIDERMAYER

Well, again I don't know how you can relate and wrap them all up, and say this is the way to go. We design a facility based on certain criteria. I understand that when we conduct these evaluations there is a lot of conservatism in them, because we really don't know what's going on out there. We do monitor the environment and we have seen in instances where we do have concentrations higher than those that were calculated for this particular facility. Again, I think that relates to things over which we have very little control -- inversions, rollovers, certain meteorological conditions. I would think that if you had 99.5 percent efficiency these could occur on occasion even at the reduced concentrations. So, I'm in favor of the environment ground level concentrations, but based on the best monitor we've got, and that's taking a look at what's happening to those plants out there.

DR. W.R. TROST

Right, which is very practical. Do you know what parts per million of SO_2 you normally operate at in your stack?

MR. A. NEIDERMAYER

The effluent of the stack?

DR. W.R. TROST

Right.

MR. A. NEIDERMAYER

It would have to be an extremely high level. I think 0.5 percent is something in the order of a thousand parts per million, so if we're five percent, it would be 10,000 parts per million.

DR. W.R. TROST

About 10,000 parts?

MR. A. NEIDERMAYER

You know, I'm guessing.

SUBMISSION RE:

ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION PLANTS IN ALBERTA

Prepared by:

PACIFIC PETROLEUMS LTD.
CALGARY, ALBERTA

FOR PRESENTATION AT THE
WHITECOURT PUBLIC HEARING SESSION
ON OCTOBER 11, 1972

Presented by: W.D. Broughton

INTRODUCTION:

Pacific Petroleums Ltd. operates the Whitecourt Gas Plant on behalf of all owners under approval number 1463 issued by the Alberta Energy Resources Conservation Board. The plant is authorized to process up to 50 MMCF/D of raw natural gas and to dispose of up to 5.65 long tons of sulphur per day as sulphur dioxide through a 300' flare stack. The design capacity of the plant is 65 MMCF/D.

The Whitecourt Gas Plant and the gas gathering system are designed to minimize emmissions to the atmosphere in the event of malfunctions. Under emergency conditions, the plant inlet and outlet valves close to strictly limit the gas volume vented through the emergency flare stack. Additionally, all wells are equipped with high and low pressure shut down devices.

SULPHUR DIOXIDE

Pacific Petroleums Ltd. has examined the possibility of recovering sulphur at the plant. However, it is highly questionable if the conversion of sulphur dioxide to sulphur would be practicable due to the adverse ratio of carbon dioxide to hydrogen sulphide in the raw feed gas. Also, the capital cost of such a project would be prohibitive. Underground disposal of the acid gas has also been investigated but capital and operating costs are prohibitive.

MONITORING SYSTEMS

A total of eight hydrogen sulphide and total sulphation stations have been distributed in the general plant area to record each month any significant departure from normally acceptable levels. Specific hydrogen sulphide and sulphur dioxide concentration measurements are periodically carried out by means of a mobile air quality monitoring station. All of these measurements are made available to the Alberta Energy Resources Conservation Board and indicate that Alberta air quality standards are being maintained.

Five corrosion measurement stations have been installed for the purpose of evaluating the atmospheric corrosion effect on various samples of metals. Corrosion measurements obtained here serve to record any change in corrosion rates or corrosion products which may occur as the result of sulphur compounds in the atmosphere.

EFFECTS ON INANIMATE PROPERTY

As the result of evidence in the form of corroded barbed wire, entered at the hearing of Whitecourt Gas Plant application No. 6150 before the Alberta Energy Resources Conservation Board on April 13, 1972, Pacific Petroleums Ltd. undertook a comprehensive investigation of environmental effects in the general vicinity of the plant. Samples of barbed wire and sheet metal were obtained from area residents and analysed by BioChem Services Ltd. to determine the cause of corrosion. The laboratory results showed that sulphur compounds were absent from the corrosion products. In summary, the corrosion products were attributed to oxygen attack. Three copies of the laboratory report were forwarded on July 31, 1972 to the Alberta Energy Resources Conservation Board.

EFFECTS ON VEGETATION

There have been no reported instances of vegetation damage in the general vicinity of the Whitecourt Gas Plant.

WHITECOURT ENVIRONMENTAL STUDY GROUP

Pacific Petroleums Ltd. is a participant in the Whitecourt Environmental Study Group. This group consists of eight companies operating twelve gas plants in this general area of Alberta. The objective of the group is to correlate all pertinent soil, air and water data and forecast the possible interaction of plant effluents on the environment. The project is currently being carried out by a consultant.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

I wonder if you could expand just a little on the problem that CO_2 provides in the recovery of H_2S.

MR. W.D. BROUGHTON

Well, the presence of carbon dioxide in the gas presents a very adverse Claus reaction. The presence of carbon dioxide would lead to the formation of carbonyl sulphide and carbon disulphide, and also severe poisoning of any catalyst. For this reason the conversion factor is very, very low.

DR. S.B. SMITH

The whole thing would be complicated then by the formation of COS and CS_2? You can't recover those easily, is that right?

MR. W.D. BROUGHTON

These are normally not recoverable from a Claus process. It requires a tail gas cleanup to take care of that.

MR. W.A. FLOOK

You say that some samples of corroded barbed wire were presented as evidence at the hearing before the Energy Resources Conservation Board in April of 1972, and some samples of barbed wire and sheet metal were obtained from area residents and analyzed. Were these samples that were obtained from the area residents the same ones that were presented in evidence at the hearings? It isn't quite clear from what you said.

MR. W.D. BROUGHTON

No, they are not the same samples, but they were from the property of the same people who did present specimens to the hearing. Our people went out and gathered these samples from the fences and from the buildings that were owned by the people who made the representations.

MR. W.A. FLOOK

How many people were involved in these complaints?

MR. W.D. BROUGHTON

Two.

MR. W.A. FLOOK

Just two? In the whole area?

MR. W.D. BROUGHTON

Yes.

MR. W.A. FLOOK

People who live downwind from your plant?

MR. W.D. BROUGHTON

Yes.

MR. W.A. FLOOK

They did? And there were no recurrences of these complaints at all in the area? The reason I seem to be stressing this is because this, as you realize, is unique in our hearings this evening.

MR. W.D. BROUGHTON

Right. As far as we know, the reports show that these particular specimens were not well protected. They were the lowest commercial grade to be purchased, and for this reason they were not really protected from oxygen attack. In other words, they were not good galvanized specimens.

MR. W.A. FLOOK

And this was the official conclusion that was arrived at as to why they corroded? Because they were inferior quality? Is that it?

MR. W.D. BROUGHTON

No, this is not so stated in the report, except that it says in the report, the biochem report, that the coating was the lowest amount that could be put on a commerical grade. In other words, higher grades could be purchased if you wished to pay more money for a better product.

MR. W.A. FLOOK

Has there been any recurrence of these complaints since then?

MR. W.D. BROUGHTON

Not to my knowledge.

DR. W.R. TROST

What is the composition of your feed gas?

MR. W.D. BROUGHTON

We have approximately 2.79% CO_2, a working average of H_2S of about 0.28 or 0.29, and the rest is raw gas.

DR. W.R. TROST

So, in fact, yours is almost a sweet gas?

MR. W.D. BROUGHTON

Yes, it's a very low percentage of acid gas.

DR. W.R. TROST

And it's because of that quite low percentage -- is it 0.2% H_2S? Is that what you said?

MR. W.D. BROUGHTON

Yes, 0.28, 0.29, in that area.

DR. W.R. TROST

It's for that reason that it's not necessary for you to extract the sulphur from it -- instead you in fact separate it as you can, and flare it?

MR. W.D. BROUGHTON

This is correct, yes.

DR. W.R. TROST

Have you thought, and I'm sure you have, of moving your flare gas material before you flare it to a sulphur recovery plant?

MR. W.D. BROUGHTON

This is not a practical consideration; we consider we would have no place where we could economically do such a thing.

DR. W.R. TROST

Are you some distance away from the other sulphur recovery plants?

MR. W.D. BROUGHTON

Yes, we're a matter of a whole lot of miles.

DR. W.R. TROST

Fifty?

MR. W.D. BROUGHTON

I would say at least that.

DR. W.R. TROST

And the volume of material you would be shipping over there isn't all that much?

MR. W.D. BROUGHTON

This is correct -- 5.65 tons a day at the present limitation.

DR. W.R. TROST

Do you have any complaints about odors?

MR. W.D. BROUGHTON

Well, there's the occasional one. We haven't anything official, but we had occasional complaints at the time when conversion would be in effect, but this is very periodic.

DR. W.R. TROST

Well, I want to take up the wire corrosion problem too. Do you know what would happen to that wire if it were in fact exposed to some sulphur dioxide?

MR. W.D. BROUGHTON

Yes, we would have the formation of iron sulphide.

DR. W.R. TROST

Are you sure?

MR. W.D. BROUGHTON

Yes.

DR. W.R. TROST

Now, if it were exposed to hydrogen sulphide you would have the formation of iron sulphide, but are you sure you would if it were exposed to sulphur dioxide?

MR. W.D. BROUGHTON

Oh, I'm sorry, we would probably get the formation of a sulphate in the event that it's exposed to sulphur dioxide.

DR. W.R. TROST

Are you sure of that?

MR. W.D. BROUGHTON

Well, I would think so. Sulphur dioxide forms a form of sulphuric acid and I think eventually that you would form some type of sulphate.

DR. W.R. TROST

And in your report -- I want to be clear about this -- it's possible that sulphur dioxide acts to facilitate rusting? The question is, does it leave any remnants of itself? In your report its reaction would be quite different from that of hydrogen sulphide; that's why I want to check about the odor. Was your report quite unambiguous in this matter?

MR. W.D. BROUGHTON

In regard to the sulphur products in it?

DR. W.R. TROST

In regard to whether or not the kind of corrosion that occurred was independent of the presence of sulphur dioxide?

MR. W.D. BROUGHTON

No, the laboratory was only concerned with determining what they considered to be the means of the corrosion attack. In this regard they analyzed for sulphur products, and having found none, and correlating the evidence before them as to the pitting attack and the products that they did find, they did conclude that this was an oxygen attack.

DR. W.R. TROST

In any event they concluded that it was an oxide, and not a sulphide, that was left?

MR. W.D. BROUGHTON

That is correct.

DR. W.R. TROST

So it wasn't hydrogen sulphide, but it was not conclusive as to how sulphur dioxide might have participated?

MR. W.D. BROUGHTON

No, it was not so stated.

SUBMISSION OF
HUDSON'S BAY OIL AND GAS COMPANY LIMITED

TO

ENVIRONMENT CONSERVATION AUTHORITY

ON

ENVIRONMENTAL EFFECTS OF THE OPERATION OF SULPHUR EXTRACTION GAS PLANTS

Presented by: H. W. Becker

WHITECOURT, ALBERTA
OCTOBER 11, 1972

Hudson's Bay Oil and Gas Company Limited
CALGARY — ALBERTA

INTRODUCTION

Hudson's Bay Oil and Gas would like to express its appreciation for the opportunity of presenting its views both to the Provincial Government through the Environment Conservation Authority, and to the public - i. e. our neighbours.

Hudson's Bay operates three sulphur plants and one gas field in the general area around Whitecourt. Since the largest sulphur plant operation we have in the vicinity comprises the Kaybob I and II plants near Fox Creek, our submission will be centered on this plant complex.

PURPOSE

Our purposes in this submission are as follows:

1) To express our full support for the Canadian Petroleum Association submission to the Environment Conservation Authority. We participated in its preparation and we endorse its conclusions and recommendations.
2) To describe briefly the Kaybob plant operation and discuss plant effluents and their monitoring and control.
3) To present our conclusions and recommendations to the Environment Conservation Authority.

DISCUSSION

A. DESCRIPTION OF KAYBOB I AND II COMPLEX

The total investment for wells, gathering systems and processing plants amounts to nearly $87 MM. Employment is provided for 135 operating staff. The Kaybob Gas Processing Plants treat a total of 340 MMSCF of raw sour gas per day and 40 MMSCF per day of raw sweet gas. The production from the wells consists of a mixture of gas, hydrocarbon liquids and salt water. The gas is treated to remove hydrogen sulphide and carbon dioxide for further processing in the sulphur plant.

The recovery efficiency of these plants is in excess of the 96% required by the original Plant Approval. The treated gas is further processed in a refrigeration unit to maximize recovery of hydrocarbon liquids and then goes to market by pipeline. Over 50% of the sales gas produced is injected back into the reservoir of origin to maintain its pressure and thus increase the recovery of liquid products.

The hydrocarbon liquids portion of the inlet feed is heated to remove hydrogen sulphide and then is cooled and delivered to storage for shipment to customers by pipeline. This product is called condensate and is used by oil refineries and chemical plants. The hydrogen sulphide is delivered to the sulphur plant.

The more volatile portions of the hydrocarbon liquids are separated into propane and butane, for marketing by either pipeline, truck or rail.

Sulphur produced at this plant is stored as either solid block sulphur, or slated sulphur. This patented slating process consists of cooling hot liquid sulphur on a continuous conveyor belt submerged in cooling water. The sulphur slates thus produced are in a crystalline form, about 1/8" thick and from four to twenty square inches in area. Production of sulphur in this form reduces the dusting problem associated with handling crushed sulphur. Ten sulphur dustfall cylinders are used to measure the dust in the area surrounding the sulphur operations.

The above processing operations result in liquid and gaseous by-products that are controlled and disposed of as follows:

I. LIQUIDS

  a. WATER

    1. SALT WATER, originating in the gas wells production stream, is removed in the liquids section, and after further treatment to eliminate noxious odors, it is pumped into a gas reservoir at over 9,000 feet depth under-

ground.

2. BLOWDOWN WATER

   The operation of cooling water towers, wherein water is recirculated in a closed system and used over and over again, results in a buildup or concentration of calcium salts similar to the scaling on a tea kettle. To prevent this scaling in plant equipment, a 3% portion of the total water circulated is removed continuously. This water, while it does not contain any oils or hydrocarbons, does contain higher than normal amounts of salts and corrosion prevention chemicals and therefore is combined with the salt water and disposed of in the same underground gas reservoir.

3. PLANT DRAIN SYSTEM WATER, is treated to remove hydrogen sulphide and hydrocarbons and collected in an earthen pond. From this storage area the water is pumped into the underground reservoir referred to above.

b. HYDROCARBON WASTE LIQUIDS

These are collected in a closed vessel and then mixed with air and burned in specially designed burning equipment. In the early startup period of the plant considerable difficulty was encountered in the control of water-hydrocarbon liquid emulsions caused through the mixing of these components in the well tubing and gathering pipeline systems. Chemicals to prevent corrosion of these systems also added to the problem of emulsion formation. The emulsion was initially disposed by burning, with the creation of a black smoke. An extensive experimental program to minimize this problem has been successful, and black smoke emission is now an infrequent occurrence. Smokeless burning equipment, costing $250,000, is installed at the plants to handle the emergency burning of fluids.

II. GASES

a. PLANT STACK GASES

There are two types of stacks for disposal of plant waste gases:

1. The Sulphur Plant Stack

   The tail gases from the sulphur plants are collected, mixed with sweet fuel gas and air, and are incinerated at the base of the stack. Incineration ensures that the sulphur compounds in the gas are converted to sulphur dioxide and are heated 1000 F. The high temperature combined with the stack height provides the dispersal of the gases in the atmosphere so as to result in proper ground level concentrations.

2. The Plant Emergency Flare Systems

   When, due to emergency or plant upset conditions, it becomes necessary to flare hydrocarbon gases from the plant, these are introduced to a flare stack 100' high. The pilot flare ignites the gases, and additional fuel gas is added to ensure necessary conditions for thermal rise and dilution to maintain safe short-term ground level concentration of sulphur dioxide.

b. GAS FIELD FLARE GASES

Under emergency conditions, or during periods of initial production of a well after remedial work, it may be necessary to burn waste gases at the wellsite. In such conditions the gas is flared through a 40' stack, and the period of time is kept to the minimum possible.

B. MONITORING TECHNIQUES

Since the control of H_2S and SO_2 is a major concern regarding environmental impact of sulphur plants, the methods used for monitoring are outlined as follows:

1) Gas Analyses. Specially developed continuously-operated industrial chromatographs are used to oversee and control plant operations.
2) Stack Emission Monitor. This involves new techniques and advanced measurement apparatus to indicate and record the instantaneous rate of SO_2 emission from the stack. As a result the operator is continuously informed of plant operation and can maintain it at the optimum.
3) Continuous Field Monitor. This consists of trailer-mounted continuous H_2S and SO_2 monitors and provides recorded information of ground level concentrations.
4) Exposure Cylinder Stations. There are 20 of the standard type of devices for measuring total sulphation and hydrogen sulphide at ground level throughout the area. This type of measurement provides a monthly total reading which is then calculated to a daily average value.
5) Sulphur Plant Material Balance. Measurements of gas volumes and analyses of the percentage composition are used to calculate the sulphur input to the plant and the disposition of this sulphur as produced elemental sulphur, sulphur in hydrocarbon liquid products, and, by difference, sulphur in the stack gases.

All of the data collected from the monitoring procedures is compiled and forwarded to either, or both, the Department of the Environment or the Energy Resources Conservation Board.

In addition to the above methods of monitoring, the operators of sulphur plants in the Whitecourt area have formed the Whitecourt Study Group. By means of aerial surveys using infra-red and thermal line-scan techniques the condition of vegetation of the area is under investigation. These special methods are combined with surface examination to determine the condition of vegetation. This long-term study was initiated this year. It is the subject of a submission to the ECA at Whitecourt.

CONCLUSIONS AND RECOMMENDATIONS

1. It is our belief that no permanent environmental damage has been attributed to our sulphur plant operations.
2. We fully endorse the CPA position that a thorough review of Ambient Air Quality Standards indicates that the existing standards are adequate to protect the environment.
3. We support the position that ground level concentrations should provide the criteria for measurement of sulphur plant operations, and that restrictions on sulphur dioxide concentrations in stack gases are unnecessary for environmental protection. Furthermore specifications of elevated sulphur recovery efficiency levels are not necessarily requisite for the attainment of satisfactory ground level concentrations.
4. We support the position that the Department of the Environment should establish Ambient Air Quality Standards according to scientific criteria, and the Energy Resources Conservation Board should continue to be the enforcing body for maintenance of these standards for the petroleum industry.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

Mr. Becker, on page 2 of your brief you state that the recovery efficiency of these plants is in excess of the 96 percent required by the original plant approval. On the average, how much in excess?

MR. H.W. BECKER

We're operating generally between the 96 and 97 percent level. I think probably an average would be 96.5 percent at present. We did appear before the Conservation Board yesterday morning in connection with our request for exemption from the guidelines for this particular plant, chiefly based on the fact that it's a cycling plant and we'll soon be reducing our sulphur production and our emissions anyway. At that time we told the Conservation Board that we felt we could by certain optimizations reach an operating level of 97 percent.

DR. S.B.SMITH

You haven't had any difficulty, then, in achieving consistently in excess of 96 percent. You know, there's bound to be . . .

MR. H.W. BECKER

No, other than let's say initial plant startup and that sort of thing, we maintained it pretty regularly.

DR. S.B. SMITH

In the same paragraph on page 2, you have indicated that over half of the sales gas is re-injected to assist in the recovery of liquid products. Two questions here; is this re-injected sales gas totally recoverable again, and how valuable, not in dollars but in general terms, is the liquid product recovery assist from this re-injection? In other words, is the position of the plant in producing liquids more favorable than that in producing gas?

MR. H.W. BECKER

That is correct. This type of reservoir is similar to the Windfall reservoir, in that greater total conservation will be effected through this procedure than would be the case if we were just simply to deplete the reservoir.

DR. S.B. SMITH

And you get back all that re-injected gas eventually, as well as the liquids?

MR. H.W. BECKER

Well, we hope so. I don't know if this is exactly true because the mechanics of reservoir production and depletion are extremely complex and it is very difficult to say what will be trapped or left in the reservoir at the time of completion of the project.

DR. S.B. SMITH

The probabilities are good, or you wouldn't be putting it back into the ground.

MR. H.W. BECKER

Well, two things: the value of the liquids produced now is undoubtedly greater than the value the gas which is produced will have, say fifteen years from now, on the one hand. On the other hand, we are required to get maximum conservation of liquids in any case.

MR. W.A. FLOOK

I'd like to talk a little bit about gas field flare stacks. These things are installations that you have out in the field? They are permanently installed?

MR. H.W. BECKER

Yes, that's correct.

MR. W.A. FLOOK

And you indicate that they are there for emergency use under emergency conditions or during periods of initial production of a well? In fact, do you put them into action deliberately or do they go into action automatically as a response to pressure fluctuations or something of that kind, or is it both?

MR. H.W. BECKER

We would put them into operation deliberately at some time such as a break in a gathering line where we have to depressure the system; that sort of thing is the chief reason.

MR. W.A. FLOOK

They never, in fact, go into operation automatically?

MR. H.W. BECKER

No, we're not rigged up that way. There should be no need for it, actually, because we have pressure-relieving devices on our systems which will relieve at the plant and so on, and we shouldn't need this.

MR. W.A. FLOOK

The point I'm trying to get down to is, what are the chances of rupturing a line leaking to atmosphere rather than to the stack that was designed to take it in an emergency situation?

MR. H.W. BECKER

Well, if one does get a leak, and this causes let's say rapid pressure drawdown in the gathering system -- in the pipeline -- then the sensing devices on the wells will shut down as a result of what we call a low pressure shut down condition. Of course, if you get a leak the only purpose then of the flare stack is so that you can open the flare stack and relieve the line pressure . . .

MR. W.A. FLOOK

And reduce the amount to the flare stack? But this doesn't happen automatically in response to the fall in pressure?

MR. H.W. BECKER

No, it doesn't. The well closes off automatically.

MR. W.A. FLOOK

In other words, somebody has to get out there and manually do it?

MR. H.W. BECKER

Yes, sir.

MR. W.A. FLOOK

And if the flare pilot light happens to be out he has got to light it?

MR. H.W. BECKER

Yes.

MR. W.A. FLOOK

So, there could be a significant lapse of time between the incident and the corrective action?

MR. H.W. BECKER

That's correct, but at the same time it will take a little bit of time to actually find the leak and locate it, and when you are there you can go to the nearest well and blow it down, and you have to shut certain valves and so on. We are actually installing an automated type of field production which will allow us to do these things from a central site.

MR. W.A. FLOOK

You say that you support the position that ground level concentration should provide criteria for measurement of sulphur plant operation. Do you mean that this should be the only control?

MR. H.W. BECKER

There is some merit, I believe, in these stack monitors that control or at least advise us continuously of the amount of sulphur going out the stack. However, we do not see the need for a restriction on the sulphur content of stack gases, nor for that matter the higher recovery efficiency level. If we design a plant and a stack for 96 percent recovery efficiency we are then planning for a certain ground level concentration. We are planning to be able to meet the required ground level concentration. If we then take out 98 percent we're simply reducing the ground level concentration further and perhaps it's a question of how good is good, how low should these ground level concentrations be. If the ground level concentrations are below levels which affect vegetation, animals, human life, etc., is there any point of reducing them still further? There is perhaps a question.

MR. W.A. FLOOK

The point, though, that I would like you to consider and probably give me an opinion on is that when you are making measurements of ground level ambient air concentration, you really are measuring a very very low concentration of the component in air, extremely low.

MR. H.W. BECKER

Yes.

MR. W.A. FLOOK

So that any inaccuracy in your method of analysis in proportion to the total quantity that you are searching for is likely to be a significant error. On the other hand, if you measure it in the stack where it is highly concentrated, a similar error would be negligible. Wouldn't you think, added to the fact that the stack is on your plant site and thus subject to greater surveillance and closer to the process where corrective action is to be taken, wouldn't this appear on the surface to be a more logical place to center your control?

MR. H.W. BECKER

I believe that the continuous stack monitors used to measure hydrogen sulphide and sulphur dioxide concentrations are really quite accurate. They measure way down to about 0.005 part per million or less, and thus they are quite sensitive. Of course, we have to rely on instruments like this to ensure that plants are meeting the requirements, the conditions of the plant approvals and air quality standards, and I believe that over the years the accuracy and reliability of these instruments have increased considerably, until today I think they are quite accurate.

MR. W.A. FLOOK

And 0.005 is still about 10 percent of what you are actually looking for, isn't it, at the controlled level?

MR. H.W. BECKER

Well, you're allowed to go as high as 0.30 for an hour.

MR. W.A. FLOOK

I beg your pardon, five hundredths of what you're looking for, which is still a significant error.

MR. H.W. BECKER

I don't really know that we could measure stack contents any closer, really. If you're going to get a ground level concentration increased by ten percent, and you don't feel that the instrument on the ground can measure that percent, I'm not sure that you can get that accuracy of measurement out of the stack either.

MR. W.A. FLOOK

In other words you think that it's just as accurate to measure at ground level?

MR. H.W. BECKER

I think the methods of measurement are really quite accurate and quite reliable today.

DR. W.R. TROST

You told us that your company is appealing the future application of the guidelines. Can you tell me how old the plant is?

MR. H.W. BECKER

The first Kaybob plant was put in in the fall of 1968 and the second one in the fall of 1969.

DR. W.R. TROST

So that they have the benefit of quite contemporary technology?

MR. H.W. BECKER

Yes, that's right.

DR. W.R. TROST

What is your sulphur treatment system in them?

MR. H.W. BECKER

We use a typical diethanol ammine for sweetening the gas, and the acid gases are then passed to three converter Claus-type plants.

DR. W.R. TROST

What is the composition of the feed gas?

MR. H.W. BECKER

It runs about 17% H_2S and about 3% CO_2.

DR. W.R. TROST

And then you put out in long tons per day of sulphur dioxide?

MR. H.W. BECKER

Approximately, of sulphur dioxide out the stack?

DR. W.R. TROST

Yes.

MR. H.W. BECKER

Our maximum allowable sulphur is 86 tons, so it's double that -- 172.

DR. W.R. TROST

Do you know, when the plant is running in a routine way, what the parts per million of sulphur dioxide in the stack are?

MR. H.W. BECKER

No, I don't know what this is, although we'll be recovering say 96.5 to 97 percent, but I don't know what they are under incinerating conditions.

DR. W.R. TROST

But it's apt to be more than 1500 parts per million, perhaps?

MR. H.W. BECKER

Yes, I think it would be a lot more. I would guess at 10,000 or something like that, maybe fifteen thousand.

DR. W.R. TROST

Are you in a good meteorological position? That is to say, the wind doesn't always blow in the same direction?

MR. H.W. BECKER

I think our wind rose indicates very similar conditions to the Chevron plant. We have a lot of relatively light winds and, if I remember correctly, probably the prevailing wind would favor northwest, and perhaps south or southeast.

DR. W.R. TROST

I suppose if there is any logic to the stack emission control total, it is that, if by some accident and inversion or a concentration of wind, gases with two thousand parts per million were somehow undiluted and put down to the ground levels, you would have an incident that would be unsatisfactory, since that is roughly four or five thousand times as high as you want. Have you any reason for taking a stand against emission control in the stack other than what you have said so far?

MR. H.W. BECKER

Well, there are several reasons, I think. The first one is that if we are presently achieving a satisfactory ground level record, for instance we're below the 24-hour maximum average of 0.10 part per million -- let's say nearly 99 percent of the time -- therefore, the amount of time and the records show that we're likewise below the 0.30 part per million for an hour; I expect about the same percentage. So we think that in fact we are achieving satisfactory ground level concentrations, and since that's the case, why go to a tremendous effort and expense to guard against, let's say, a spot meteorological condition with a low likelihood of happening frequently.

DR. W.R. TROST

Is the cost and the effort of the stack monitoring in fact that substantial?

MR. H.W. BECKER

This was in the Canadian Petroleum Association report and, if I recall the numbers correctly, the cost of all the plants of Alberta getting down to a thousand parts per million in the stack is something of the order of a half a billion dollars, and this is very close to the total investment in the industry today.

DR. W.R. TROST

So your answer is that it is fairly substantial?

MR. H.W. BECKER

Yes, extremely so. And the operating cost I think would be likewise.

DR. W.R. TROST

Have you any additional reason why, again in Recommendation 3, you suggest that further specifications of elevated sulphur recovery efficiency levels are not necessarily requisite for satisfactory ground level concentration? It would be quite a departure in policy, wouldn't it be, on the part of the Board?

MR. H.W. BECKER

Yes, it is. I think that our chief reason for feeling this way and making this statement in the submission is that, in the case of Kaybob, here we are, running between 96 and 97 percent. We are, according to the records that we have and which the Department of the Environment has, meeting ground level standard requirements and therefore not damaging vegetation, animals, human life, etc. Since this is the case -- our stack was designed for 96 percent recovery, and produces proper ground level concentrations -- if we go up to 98 percent we don't feel that we have done any benefit to anybody, since we weren't hurting anything in the first place. So, we feel it's an unnecessary cost. If we were to design for 98 percent in the first place, and design our stack accordingly, then you would get a proper balance of what you are doing in the plant.

DR. W.R. TROST

So your basic position is that if the ambient ground levels were defined, everything else would follow in due order.

MR. W.H. BECKER

Yes. And really that the sulphur plant operators, the companies involved, will plan their plants so as to best achieve the ground level concentrations. If they feel that the best approach for them with a particular meteorological area is 99 percent recovery to achieve that, then they would have to go to that. If they're in a better area, if they are in let's say the Kaybob 1 and 2 area, then the 96 percent in our present stack design should fill the requirements and meet the ground level conditions necessary.

DR. W.R. TROST

As you know, one of our terms of reference is to look into the suitability of regulations and legislation as they presently exist. Leaving aside the fact that you are appealing the application of the future guidelines, have you any comment about the suitability of regulations and legislation as they presently exist?

MR. H.W. BECKER

No, I think that as they presently exist they are generally quite satisfactory. I believe there is a confusion between absolute air quality standards and stack design air quality standards. The Department of the Environment has both an ambient air quality standard which is well spelled out and well delineated, and also a calculated ground level standard which is for the purpose of equipment design, stack design. The Conservation Board has put into effect regulations which require the operators of sour gas processing plants to operate their plants in such a way that they will meet certain standards, and these standards are really the calculating standards of the Department of the Environment. Instead of the 0.30 absolute average maximum allowable of SO_2 for an hour, the Conservation Board standard is 0.2 for half an hour in certain areas and 0.3 for half an hour in other areas, so there is a little bit of confusion there, and the Conservation Board perhaps has tighter standards than the Department of the Environment. We feel that the standards should actually be set in accordance with established scientific data and information as to the threshold levels for damage, and that essentially the Conservation Board should continue to enforce these standards that are set by the Department of the Environment.

County of Lac Ste. Anne
No. 28
SANGUDO, ALBERTA, CANADA

OFFICE OF THE SECRETARY - TREASURER

OUR FILE ______________

Re: Environmental Effects of the Operation of Sulphur Extraction Gas Plants

Brief for presentation to the Environment Conservation Authority at the public hearing to be held Wednesday, October 11, 1972 at Whitecourt, Alberta

Presented by: J. B. McDonald

Some other alternative should be implemented to reduce the amount of waste products placed in the air. The high stacks and large turbines presently used are simply placing the emitted residues into a higher atmosphere which are coming back to ground level over a large area. The odor emitted is at times quite offensive and the residue has a corrosive effect on barb wire and other metals and galvanized objects. Television sets, i.e., fine tuners and channel selectors require a greater degree of servicing in order to function.

Submitted by J. B. McDonald on behalf of the Council of the County of Lac Ste. Anne No. 28.

QUESTIONING BY THE AUTHORITY

DR. S.B. SMITH

With respect to the barbed wire that you gave us a sample of, how long does barbed wire last, or how long did that wire last?

MR. J.B. MCDONALD

That wire was installed in about 1966. Now, a man previously said that barbed wire of inferior quality rusted. This barbed wire is of inferior quality. The galvanize on it is not as heavy as is obtainable on some wire, but if it will affect the galvanizing of inferior wire within a short period of time, then I must assume that wire of a better quality in time will rust too.

DR. S.B. SMITH

How much fencing did you have on your property, and how much trouble have you had with it?

MR. J.B. MCDONALD

I have, on my half section where I run my cattle, approximately seven miles of fencing.

DR. S.B. SMITH

Four strand?

MR. J.B. MCDONALD

The outside wire is four strand. The inside is two strand. Up to now the better quality wire hasn't broken from rust. The inferior quality barbed wire, which is about $3 to $4 a spool cheaper, will break from rust when it is stretched too tight.

DR. S.B. SMITH

Do you have buildings on this property that are painted?

MR. J.B.MCDONALD

We have painted buildings; we do not have any buildings with any galvanized sheet metal on them. We have not noticed any detrimental effects to the buildings or the machinery.

MR. W.A. FLOOK

You say you occasionally get offensive odors from the plant?

MR. J.B. MCDONALD

Yes, this would be more with the weather conditions; it isn't a general condition. If we have a very calm day, we seem to have more odors. If we have a breeze, there is not too much problem.

MR. W.A. FLOOK

You are downwind from the plant?

MR. J.B. MCDONALD

I am downwind from the plant.

MR. W.A. FLOOK

Is it worse in winter than in summer, I suppose?

MR. J.B. MCDONALD

No, I would say that atmospheric conditions have more bearing on the odor than seasons. If you have a calm day, if you noticed when we used to have the old wood stove, the smoke would come straight down. This seems to be the condition that bothers us most.

MR. W.A. FLOOK

How often do you have these bad conditions? Once a month?

MR. J.B. MCDONALD

No, I don't think so.

MR. W.A. FLOOK

Not as often?

MR. J.B. MCDONALD

No.

MR. W.A. FLOOK

When you have them do you ever call the plant and tell them about it?

MR. J.B. MCDONALD

I haven't myself, but I am sure some people have.

DR. W.R. TROST

Mr. McDonald, this submission is placed before us on behalf of the Council of the County of Lac St. Anne. Has the County received complaints from citizens in the County?

MR. J.B. MCDONALD

No, I would say not.

DR. W.R. TROST

Have you had any health problems, either . . .

MR. J.B. MCDONALD

No, I don't think we've had any health problems with ourselves or our livestock that could be assumed of the environment.

DR. W.R. TROST

But in respect of the particular effects that you cite, do you feel it would be helpful to the County if they had a participation of some sort in the co-operative research program that the companies are managing?

MR. J.B. MCDONALD

Yes, I would say it would be a help to us. The plant in our area has been quite co-operative, and when they were planning to expand they placed their submission before us and told us what they were trying to do.

DR. W.R. TROST

Over how many years have these odors and so on been present in the community?

MR. J.B. MCDONALD

Since this plant was built south of Mayerthorpe.

DR. W.R. TROST

And that would be how long?

MR. J.B. MCDONALD

I think it was built in 1966 or so.

DR. W.R. TROST

I have a note saying that Mr. Neidermayer has completed his calculations. Mr. Neidermayer please. Do come up to the microphone so that it's on the record.

MR. A. NEIDERMAYER

We are fortunate in having our Whitecourt area office in Whitecourt, and we were able to go to the office and get these numbers. The numbers that you requested are an average for the period 1970 to 1971 inclusive. They are for direct operating costs only, and the actual throughputs experienced during that time. The cost of treating our sour gas feed is 1.42 cents per mcf of sales gas.